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ABSTRACT

A solid background in math, science, and technology is vital to competing in today's workforce, as well as necessary to understanding the world in which we live. Mastery of technology is now necessary even in traditionally vocational careers, as some of today's automobiles have more computing power than a personal computer. New York City private sector job growth has been concentrated in areas which require a foundation in math, science, and technology. This report looks at recent steps taken, as well as the many barriers which remain, to making New York City high school graduates genuinely competitive in science, math and technology. These steps began under then Chancellor Cortines in 1994 with the introduction of the Citywide Math and Science Initiative, which required all entering high school students to take 3 years of Regents-level math and laboratory science. Chancellor Crew has continued this initiative, adding greatly needed standards and resources for technology to the schools. We are far from achieving the primary goal established by the Citywide Math and Science Initiative--namely, that all students develop math and science skills at the Regents level. In addition to documenting barriers to the Initiative's complete and successful implementation, this study makes recommendations which constitute an agenda for what must be done in the coming years. The methodology utilized combined field interviews and observations with a review of relevant test scores, budget and policy data produced by the New York City Board of Education and the New York State Department of Education. Field work included staff interviews and inspections of science laboratories at 19 high schools chosen to represent all five boroughs and the range of academic performance. (ASK)

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EXECUTIVE SUMMARY

A solid background in math, science and technology is vital to compete in today's workforce, as well as necessary to understanding the world in which we live. Mastery of technology is now necessary even in traditionally vocational careers, as some of today's automobiles have more computing power than a PC. New York City private sector job growth has been concentrated in areas which require a foundation in math, science and technology.

This report looks at recent steps taken, as well as the many barriers which remain, to making our City high school graduates genuinely competitive in science, math and technology. These steps began under then Chancellor Cortines in 1994 with the introduction of the Citywide Math and Science Initiative, which required all entering high school students to take three years of Regents-level math and laboratory science. Chancellor Crew has continued this initiative, adding greatly needed standards and resources for technology to the schools.

As this report shows, we are far from achieving the primary goal established by the Citywide Math and Science Initiative - namely, that all students develop math and science skills at the Regents level. In addition to documenting barriers to the Initiative's complete and successful implementation, this study makes recommendations which constitute an agenda for what must be done in the coming years.

The methodology utilized for this study combined field interviews and observations with a review of relevant test scores, budget and policy data produced by the New York City Board of Education and the New York State Department of Education. Fieldwork included staff interviews and inspections of science laboratories at 19 high schools, chosen to represent all five boroughs and the range of academic performance.

KEY FINDINGS AND OBSERVATIONS

- **Students are poorly prepared academically in the early grades in math and science.** Many students enter ninth grade without basic math and science skills, making higher level work virtually impossible. Causes of this poor preparation include inconsistent curricula in the early grades and high student mobility rates which interrupt individual learning.

- **There is a shortage of qualified math, science and technology professionals.** When the Board of Education is unable to attract and keep enough math and science teachers, shortages must be filled by unqualified teachers. During the 1996-97 school year, 15.9 percent of New York City math teachers held temporary teaching licenses; in New York State as a whole, just 5.9 percent were similarly uncertified. In the same school year, 30.4 percent of New York

City's science teachers held temporary licenses; in New York State, just 6.7 percent of science teachers were uncertified.

- **The science teacher shortage has reached crisis proportions**. In 1992-93, 16.5 percent of science teachers were uncertified. By 1996-97, despite overall decreases in the numbers of uncertified teachers, the proportion of science teachers who were uncertified actually rose to 30.4 percent.

- **Poor hiring practices by the Board of Education, as well as the comparatively low salaries paid to New York City teachers, represent barriers to relieving the shortage of math and science teachers**. The City has additional licensing requirements that take candidates more than a year to complete and add little useful information to the State licensing system. Median teacher salaries in the suburban counties far outstrip those in New York City - in Suffolk County, teachers are paid an astounding $20,764 more each year.

- **Laboratory specialists, critical to the successful implementation of any good science program, are in short supply.** The number of laboratory specialists Citywide has decreased by 52 percent, from 411 in 1974 to 195 in 1997. This is despite the fact that by 1997, the numbers of students returned to 1974 levels, after decreasing during the 1980s.

- **Many New York City teachers come poorly prepared to teach math, science and technology.** Of the prospective teachers from CUNY who in 1996 took the State Liberal Arts and Science Test, necessary for certification, 38 percent failed. Approximately half of New York City public school teachers are CUNY graduates.

- **Twenty three percent - 1,532 - of all City math and science teachers have two years or less classroom experience.** Compounding the problem, the least qualified teachers are teaching the students most at risk. The majority of unqualified teachers are placed in the worst performing schools, with no mentorship and little professional development, leading to high attrition rates and low levels of teacher effectiveness. On the whole, New York City public school teachers average only 13 years teaching experience, as compared to an average of 17 years for the five large city school districts in New York State.

- **Poor staff development impedes math and science education in the City's public schools.** Few elementary school teachers have had any special training in teaching science or math, and are only required to have had six course credits in science *and* math for licensure. Few high school science and math teachers have had any experience in teaching Regents courses to students, although the Citywide Math and Science Initiative requires students to take these courses. Despite the need for broad scale staff development, the Multiple Disciplinary Resource Centers (MDRC) each year are able to train fewer than 20 percent (7,500) of the City's 42,000 elementary, middle and high school science and math teachers. In addition, there is a lack of coordination by the Board of the various professional development and enrichment opportunities offered by private and not-for-profit institutions within New York City. It has taken until the 1997-98 school year - the fourth year of a five-

year grant period - for the Board of Education to implement the New York City Urban Systemic Initiative, a professional development program established with a $15 million grant by the National Science Foundation.

- **There is a dire need for additional laboratories to serve the growing student population.** In our survey of 19 schools, one school had no dedicated science laboratory, a circumstance, according to the Board's first evaluation of the Citywide Math and Science Initiative, that is not unique. In schools with laboratories, many are unable to support any high-level experimentation because they serve several science subjects rather than being specialized for one. All 18 of the schools in our survey which had science laboratories, had at least one which was shared. Safety in school laboratories is compromised for both students and teachers as a result of high utilization and/or inadequate safety equipment.

- **In too many instances, laboratory experiments are scheduled - not to challenge and stimulate students - but rather to fit budget, time, and personnel constraints.** The overwhelming majority of students in our survey experienced restrictive single-period lab experiments, and never benefited from double-period laboratory scheduling as recommended by the State. In 16 of the 19 schools, some laboratory classes were scheduled for single periods; in only three schools were double-period laboratory classes the norm.

- **The Board of Education has also failed to provide adequate science equipment and supplies to foster students' interest in science and permit a high level of scientific investigation**. Unfortunately, in most of the schools surveyed, the science budget has not increased in proportion to increases in the number of science classes resulting from the Citywide Math and Science Initiative. While the number of laboratory classes in our survey sample increased by 191 percent between the 1993-94 and 1996-97 school years, the average science budget increased by a mere 9.7 percent. In several schools, the science supply budget actually *shrank* over the three years. These included South Shore High School in Brooklyn, where the science budget decreased by 23 percent while the number of laboratory classes increased by 71 percent; and Jamaica High School in Queens, where the budget decreased by 5 percent while the number of laboratory classes increased by 200 percent.

- **All of the 19 schools surveyed (100 percent) had substantial equipment deficiencies such as a shortage of gas lines, running water, power packs, microscopes and beam balances**. Shortages included running water, often due to broken faucets, in ten (53 percent) of the labs; gas to fuel experiments, often due to broken gas jets, in ten (53 percent) of the labs; and microscopes, many of which were broken, in 14 (74 percent) of the labs. In addition, ventilation was inadequate in 15 (79 percent) of the labs, as a result of inoperable ventilation hoods or the complete absence of a ventilation system.

- **The effective ratio of students to computer, excluding outdated machines, is too high and some Community School Districts need to completely replace their computers due to obsolescence**. New York City high schools average 115 students for each current (Pentium or Power Mac multimedia technology) computer; elementary and middle schools

average 103 students per current computer. The Board's current technology plan recommends student-to-computer ratios of 8:1 for elementary and middle schools and 6:1 for high schools. These ratios are for current, not outdated, machines.

- **Too few schools have active PA/PTAs,** thereby missing an opportunity to provide support to parents and students to pursue high-level math, science and technology studies.

- **Negative peer pressure has an adverse effect on too many students,** especially minority students and girls, derailing their otherwise high achievement in math and the sciences.

RECOMMENDATIONS TO THE BOARD OF EDUCATION:

- **Create a Citywide strategic plan for reforming math, science and technology education which goes beyond its current New York City Urban Systemic Initiative effort.** This plan should involve all New Yorkers, especially parents, teachers, science-rich institutions and business organizations. The science-rich community is already involved and eager to provide professional development and other educational enrichment programs for teachers and students. There are excellent programs that should be expanded and replicated.

- **Continue to improve the hiring and retention of new, qualified math and science teachers and laboratory specialists, including alternative recruitment efforts, such as the Board's recent recruitment of Austrian teachers.** This would include:

  - Supporting the National Council for Accreditation of Teacher Education accreditation of CUNY teacher training colleges by the State Education Department.

  - Offering scholarships and loan forgiveness programs similar to those currently offered for special education and bilingual teachers.

  - Phasing in increased starting salaries, incentives for high-level performance, and a sign-on bonuses for hard-to-find math and science teachers.

- **Create a consolidated math, science and technology center in each borough.** Although the Board has already changed the names of existing centers to Multiple Disciplinary Resource Centers, their functions remain separate. Staffing levels at the new centers should be increased to provide training as well as follow-up.

- **Coordinate the disparate public and private professional development programs in the City.**

- **Bring all science laboratories up to working order by correcting major equipment deficiencies.** This would include the School Construction Authority stepping up its construction and rehabilitation of laboratories, as well as the Board of Education:

  - Adding new laboratories to schools where feasible, and improving the process by which chemicals and supplies are purchased.

  - Implementing some number of double-period laboratory sessions in all high schools.

  - Increasing the annual allotment for laboratory supplies in accordance with the increase in the number of Regents science classes.

  - Improving the maintenance of laboratories.

- **Ensure that all students have reasonable access to current technology.** The Board of Education should work toward meeting the standards recommended in its technology plan of six students per computer in high schools and eight students per computer in elementary and middle schools, as well as connecting every classroom and library to the Internet.

- **Ensure that all schools have active PAs/PTAs**. These PAs/PTAs can then be more active in encouraging parental support of students' math and science activities. All school districts should have a dedicated full-time position of parent liaison to ensure a high level of support at the district level.

- **Expand the current high school peer counseling network to incorporate elementary and middle schools.** The Board of Education should also embark on a campaign to improve students' attitudes towards math and science through positive peer influence and a City-wide public service advertising campaign aimed at changing students' and parents' perceptions.

BOARD OF EDUCATION COMMENTS

We provided a copy of a draft report to the Board and met with representatives from the Division of High Schools, School Facilities, Instructional Support, Assessment and Accountability and the Office of Parent Advocacy. They provided comments on our draft, which are incorporated where appropriate. The Board essentially agreed with most of our findings.

The Board has already taken actions to implement some of our recommendations. Specifically, the process of purchasing chemical supplies for laboratories is being reevaluated for improvement: a committee comprised of science teachers and lab specialists was formed to evaluate the chemicals and supplies needed, and the Board plans to employ existing computer systems to track the status of supplies already in stock.

1

INTRODUCTION

THE IMPORTANCE OF A RIGOROUS EDUCATION IN MATH AND SCIENCE

A solid background in math, science and technology is vital not just to compete in today's workforce, but also to participate in discussions of scientific issues that affect society. On the eve of the twenty-first century, tomorrow's workers must be even better prepared for the rapid change of the Information Age. Even in traditionally vocational careers, mastery of technology is necessary. The National Automotive Technicians Education Foundation, in its new standard for automotive training, concluded that skills in science, math and language arts are just as vital to would-be mechanics or technicians as they are to college bound students.[1] One auto-chain administrator stated "If you want to know whether the sparks plugs need to be replaced on a car, you've got to know how to use software on a PC that's running Windows."[2]

More and more, businesses must respond to a growing demand for improved product quality and shorter product cycles. Global competition forces companies to operate efficiently and the role of technology in the workplace is increasing exponentially. The productivity of our society is related to the scientific and technological skills of our work force. It is a key to opportunity and careers in the age of communications and technology.[3] A study by the New York State Department of Labor explains that corporations expect employees to be self-motivated problem solvers with the flexibility to adjust to changes in both the market place and technology. A list of minimum skills required for success includes higher math and science skills.[4] Even with high

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[1]West, P., *New Standards Specify Essential Skills Required by Automotive Students*, Education Week, November 15, 1995, p. 8.

[2]Chandrasekaran, Rajiv, *A Seller's Market for Tech Workers; as Jobs Go Begging, Firms Downsize Plans*, The Washington Post, November 30, 1997, p. A1.

[3] Jones, Thomas R., *Higher Education: The Opportunity Ticket*, The Children's Times, October 1995, p. 2.

[4] New York State Department of Labor, Division of Research and Statistics, *Tomorrow's Jobs Tomorrow's Workers, New York City Region 1995-96*, p. 18.

unemployment rates employers find that the majority of applicants for entry-level jobs - in some cases 95 percent - do not meet minimum standards for hiring.[5]

In the last 30 years the composition of the workforce in New York City has undergone dramatic changes. A proliferation of service sector jobs has forced a demand for higher-skilled and better-educated workers. Between 1965 and 1995 the City lost 592,100 manufacturing, mostly low-skilled, jobs while gaining 479,700 service sector jobs. In 1965, there were 164,700 more manufacturing jobs than there were service sector jobs. By 1995, there were 907,100 more service sector jobs than manufacturing jobs.

The New York City private sector has seen an increase in jobs since 1994. These new jobs are focused in a few noteworthy spots, namely printing and publishing, a new emerging multimedia, the securities industry, retail, and tourism. However, jobs in these areas of growth are becoming increasingly more technical in nature.[6] Manufacturing jobs can pay reasonably well, but are more likely to do so when the employee possesses a high level of knowledge and skills, which include subjects such as trigonometry and physics.[7]

Projections show that minorities and women will account for the majority of the labor force growth. Given these facts, it is imperative that we encourage all our youngsters, and challenge them to achieve high academic standards, particularly in math, science and technology.

Aside from increasing the chances of securing a well-paying job, individuals need math, science and technology skills to fully participate in our society. Science permeates the news like never before. To fully understand current events individuals must understand principles of math, science and technology. For example, patients can exercise better health-care choices if they have a good understanding of biology. A science background is necessary to understand the cloning of sheep, DNA fingerprinting or the environmental consequences of ozone depletion or poor watershed protection. A generation ago, a prospective home owner would sign a simple mortgage for a fixed annual interest rate. Today, a prospective home buyer has to choose from unlimited combinations of variable interest rates, points and terms. People who are adept at using new technology can reap the rewards. Technology so permeates our society that many take advantage of their familiarity with the common-place technologies such as computers, fax machines, modems and the Internet by telecommuting, taking work home, or starting home based businesses.

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[5]Kotkin, Joel, *High Anxiety Labor; Shortage of Skilled Workers*, Los Angeles Times, November 2, 1997, p. M1.

[6]New York State Department of Labor, Op. Cit. p. 4-7.

[7]Barth, Patte, *Want to Keep American Jobs and Avert Class Division? Try High School Trig.*, Education Week, November 26, 1997, p. 30.

With such a need for competency in math, science and technology New York City's students are the big losers. Many stopped studying or progressing in math and science at an early age, or took "bonehead", or easier courses.[8] The courses, such as Fundamentals of Mathematics, Consumer Mathematics, Physical Science and Human Biology, introduced in the 1970s, were mainly watered-down versions of college preparatory courses. Sometimes teachers, guidance counselors, parents and administrators encouraged these choices. Over time, as the educational system required less from our students, they responded predictably by achieving less: the portion of the students receiving Regents endorsed diplomas went from 32 percent in 1983 to 19 percent 1996.[9] There was a shift from Regents level courses to the watered-down Regents Competency Tests (RCT) for high school students. In 1994 when the Chancellor instituted more stringent standards, many students were failing even the RCTs. For example, in 1994, only 47 percent of the students taking the RCT science exam and 46 percent of the students taking the RCT math exam achieved a passing grade.[10]

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[8]As characterized by ex-Chancellor Cortines, see, Newman, Maria, *Cortines Hails Effort to Push Tough Classes*, New York Times, May 9, 1995, p. B1.

[9]New York State Education Department, *Statistical Profiles of Public School Districts*, February 1997, p. 15.

[10]New York City Board of Education. Data includes result from both winter and spring exams.

2

BACKGROUND

Since the 1970's, there has been a significant decline in the performance of New York City public school students in math and science. SAT scores declined as did student participation in Regents courses.[11] Although test results show overall improvement since the early 1990's, the number of students taking high level courses in math, science and technology is low. An astonishing number of students failed the easy Regents Competency Test (RCTs) that they were required to pass, prior to 1994, to receive a high school diploma. In Spring 1993, 26,038 students, or 54 percent, failed the math RCT exams. A similar number, 25,104 students or 58.8 percent, failed the science exam taken at the same time.

IMPLEMENTING FEDERAL AND STATE STANDARDS

There is gathering momentum for improved math and science education all across the country. A 1983 report entitled "Nation at Risk"[12] demonstrated many systemic deficiencies in public education in the United States. This report is significant because many of its findings are still true in New York City today, 15 years later. Some of the report's key findings were: students have migrated from college preparatory programs to general track courses in large numbers; 25 percent of the credits earned by high school students are in physical education, remedial English and remedial math; expectations of students were low in many areas, including choice of subjects, mastery of subject matter and diploma requirements; not enough academically able students became teachers, the shortage of teachers in math and science was severe and half of the math, science and English teachers were not qualified to teach their subjects. As a result of this report, states all across the nation started strengthening their public schools curricula, particularly in math and science.

Historically, education has been a local issue, but the inadequacies of the education system have become so apparent that Federal standards now are seen as necessary to improve national

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[11]New York City Comptroller's Office, *The State of Math and Science Education in the New York City School System*, June 15, 1982.

[12]National Commission on Excellence in Education, *A Nation at Risk: The Imperative for Educational Reform*, April 1983.

American education. It set goals for student performance, math and science achievement, teacher training and professional development and the condition of the school environment, to be met by the year 2000. Further reflecting the growing national consensus for fundamental change in the structure of American education, President Clinton in his 1997 State of the Union address, announced that his number one priority was to ensure that all Americans have the best education in the world. He issued a ten-point plan, known as "President Clinton's Call to Action." The call to action sets rigorous national standards, with national tests in 4th grade reading and 8th grade math. It also set goals for student performance, the quality of teachers, parental involvement, adult education, technology and Internet access and scholarships and tax law revisions to pay for the first two years in college.

In the Fall of 1995, the New York State Commissioner of Education began focusing on similar improvement in standards for high school students throughout the state. The State Board of Regents has already begun to completely phase out the RCTs as the minimum standards for high school graduation. Beginning in the school year 1996-97, entering 9th graders have to pass the Regents English exams before they graduate. Last school year, 1997-98, Regents Mathematics was added to the requirement, and this year, 1998-99, Social Studies (Global Studies and U.S History and Government). The sciences (Biology, Chemistry, Earth Science and Physics) will be added next year, see Table 1 below.

Table 1, Implementation Schedule of New York State Board of Regents New High School Standards

	Year Student Enters 9th Grade - High School			
	1996-97	**1997-98**	**1998-99**	**1999-00**
Subjects taken before graduation	English	English Mathematics	English Mathematics Social-Studies	English Mathematics Social-Studies Sciences

Source: New York State Education Department

Aside from requiring that all students pass the Regents exams to receive a high school diploma the State Education Department is planning more rigorous exams by the year 2002. Therefore, within a few years, New York City students will face a monumental task of moving from the RCTs to the current Regents exams and then to even tougher Regents exam standards. As an indication of the tremendous academic preparation needed for these improved requirements and standards, approximately 80 percent of high school students, statewide, who took an experimental version of the new Regents math exam failed. The failure rate was higher than expected for students enrolled in honors classes, 38 percent, and dismal for students in special education classes, 95 percent.

3

THE NEW YORK CITY MATH AND SCIENCE INITIATIVE

On May 1, 1994, a Citywide Math and Science Initiative (the Initiative) was announced by former Chancellor Cortines with much fanfare. [13] Prior to the 1994-1995 academic year, few New York City public high school students took advanced courses. In the 1993-94 school year, the year before the math and science initiative began, 30 percent of enrolled high school students took the Regents Biology exam and 63 percent of those passed. For Physics, the numbers were substantially less, 14 percent of the students took the exam and 71 percent of those passed. A student could graduate from high school without ever taking an algebra or other Regents-level course in any subject.

In an attempt to address the problem of poor student performance, the former chancellor, Ramon Cortines, mandated that beginning in September 1994, entering ninth and tenth grade students, including special education students and students with limited English proficiency, be required to take three years of academic courses in math instead of the watered-down courses that most students had taken over the last 15 years. This mandate meant that in order to graduate, students would be required to take three years of Regents-level math topics such as algebra, geometry and trigonometry. Students were required to take three years of science but not academic-level science. Then, in the following year, 1995, the Board passed a resolution requiring three years of laboratory science for high school graduation, beginning in that year. Students who are not prepared for Regent-level work are allow to take a one-year preparatory course followed by two years of Regents-level courses.

The Initiative has resulted in a rising level of expectation of student performance. A large number of students who would have been tracked into non-college preparatory courses, are taking and passing the Regents-level math and science exams. For example, between 1994 and

[13]The City-wide Initiative follows the Brooklyn High School Superintendency's own initiative implemented in 1991. Brooklyn's program required that students entering ninth grade and performing above the 30th percentile in the Degrees of Reading Power (DRP) Test be enrolled in Regents-level Sequential Mathematics. Three years later, Brooklyn raised its student expectations in science by requiring entering ninth grade students to take Regents-level science courses.

1996, there was a 172 percent increase, or an additional 30,325[14] students, in the number of entering 9th graders taking Regent-level science courses, resulting in an increase of 133 percent, or an additional 17,387 students, passing the exams. During the same period, enrollment increased by just 4 percent, or 2,230 students.

Although the Initiative was started before his arrival, Chancellor Crew has expressed high expectations for student performance and has augmented the Initiative with complementary programs. In his 1997-98 budget request, Chancellor Crew declared specific literacy and technology goals for elementary and middle schools, areas that badly need improvement. The Chancellors' efforts not withstanding, a substantial number of students are not participating in or failing the more rigorous courses. For example, in Spring 1996, more than 9,800 students, or 17 percent, of the 57,800 entering ninth graders did not take Regents-level science courses. More than 17,500 students, or 47 percent, of those taking the Regents-level exams failed.

It is important that we remember that we are only in the initial phase of a process that, if it is to succeed, must bring together many other disparate processes, all with the same goal of high expectation and achievement for all of our children. It is essential that we realize that teachers and parents are critical players in achieving our goals, and ways must be found to empower and support them.

CHALLENGES FACED BY THE NEW INITIATIVE

The decision to implement the City-wide initiative for public high school students was a step in the right direction, but a lot more work must be done to attain the standard of education the Chancellor had set out to achieve. Several factors make this undertaking particularly challenging.

At the time the new Initiative was announced, the school system was operating in a tumultuous environment. Not only is the New York City school system the largest school system in the nation, but it is continuing to grow.[15] Enrollment grew from 1,016,728 students in SY 1993-94 to 1,057,344 students in SY 1995-96. While enrollment was growing and the new Initiative was being implemented, the amount of City funding to the school system decreased. In several rounds of cuts between FY 94 and FY 96 the City decreased its tax levy funding to the Board by three percent while enrollment grew by 4 percent. The resulting decrease in per student funding by the City was 6.7 percent. Between FY 96 and FY 98, the City significantly increased tax levy funding to the Board by 22.2 percent, or from $3.13 billion to $3.82 billion. In comparison, the student population increased by 2.6 percent. The resulting increase in per student funding was 19.2 percent.

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[14]This figure includes 10,851 students who took the Foundations of Science course. The Foundations course was established in the 1994-95 schools year to improve the preparation of students for Regents-level courses and exams.

[15]The New York City school system occupies 1,100 buildings and employs 68,700 teachers.

Immigration presents another challenge. The primary cause of the increasing student enrollment is the substantial increase in immigration over the last two decades. In the 1980s, 85,600 immigrants arrived annually in New York City, by the early 1990s, the number increased by 32 percent to 112,600 annually. For approximately 63 percent of these immigrants, English is not their primary language. Most send their children to public schools. In 1998, the percentage of immigrants making up the school population was 10.3 percent.[16] These immigrant students have varying levels of academic preparation in their native countries and their ability to communicate in English is often very weak.[17]

According to the Board's first progress report on the Initiative, in 1995, most school laboratories were poorly equipped, and some schools had no science laboratory.[18] Furthermore, Regents level math and science books and materials were frequently unavailable.[19] As part of our report, we surveyed 19 high school science laboratories to determine their current condition. Our findings are presented later in this report.

It is fair to say that four years after the Initiative was implemented we are still far from where we need to be with regard to student performance and the support system necessary for the goals to be met. The Board has produced two progress reports. The first outlined many of the systemic problems facing the Initiative and the second showed the progress made in higher student participation rates in Regents-level courses.[20] Table 2 shows that the pass rates have declined in Regents-level subjects. A drop in the pass rate was expected since many more students are taking Regents exams and most of these students were not adequately prepared for high level achievement when they were in elementary and middle grades. Even though the pass rate has dropped, it should be noted that in absolute numbers, more students are passing the Regents exams than before as a result of the Initiative. Table 2 shows that thousands of students are still failing. This report outlines in detail causes of failure and what can be done to help correct this problem. It also looks at the conditions facing the average public school student.

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[16]Board of Education, Office of User Support Services. The Board has reported higher numbers in the past, but has revised it's earlier numbers partially because of improvements in the methodology of the calculations and an observed decline in overall immigration and non-English speaking students coming into the public school system.

[17] Board of Education of the City of New York, *Mathematics and Science Initiative in the High Schools: A Progress Report*, May 1995, p. I.

[18]Ibid

[19]Ibid.

[20]Among the findings are: weak academic preparation in basic mathematics and English skills of many students entering high schools, the unavailability of necessary materials and supplies, including appropriate texts and manipulatives, shortage of laboratories, laboratory equipment and materials, shortage of math and science teachers and laboratory specialists, and inadequate teacher training for Regents-level instruction in mathematics and science.

Table 2, New York City Regents Examination Outcomes, Selected Subjects

Examination	Outcome	1993-94	1996-97	Change[1] from 1993-94 to 1996-97	% Change from 1993-94 to 1996-97
Sequential 1 Math	Total Taking Exam	39,190	55,924	16,734	42.7%
	Number Passing	22,365	24,929	2,564	11.5%
	% Passing	57.1	44.6		-12.5%
Sequential 2 Math	Total Taking Exam	23,600	33,468	9,868	41.8 %
	Number Passing	15,115	17,664	2,549	16.9 %
	% Passing	64.0	52.8		-11.3 %
Sequential 3 Math	Total Taking Exam	14,794	19,144	19,144	29.4 %
	Number Passing	10,284	13,592	3,308	32.2 %
	% Passing	69.5	71.0		1.5 %
Biology	Total Taking Exam	20,015	26,700	6,685	33.4 %
	Number Passing	12,082	11,415	(667)	-5.5 %
	% Passing	60.4	42.8		-17.6 %
Chemistry	Total Taking Exam	14,691	21,557	6,866	46.7 %
	Number Passing	9,963	10,698	735	7.4 %
	% Passing	67.8	49.6		-18.2 %
Physics	Total Taking Exam	7,985	10,492	2,507	31.4 %
	Number Passing	5,763	7,316	1,553	26.9 %
	% Passing	72.2	69.7		-2.4 %
Earth Science	Total Taking Exam	9,317	16,510	7,193	77.2 %
	Number Passing	6,353	8,032	1,679	26.4 %
	% Passing	68.2	48.6		-19.5 %
English	Total Taking Exam	25,399	33,021	7,622	30.0 %
	Number Passing	17,376	21,642	4,266	24.6 %
	% Passing	68.4	65.5		-2.9 %

Source: Board of Education

[1] The data is not adjusted for the increase in enrollment between SY 93-94 and SY 95-96. Overall enrollment in academic high schools increased by 3,410 students, or 1.6 %, from 219,920 in SY 93-94 to 223,330 in SY 95-96.

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4

CONDITIONS THAT PROHIBIT THE INITIATIVE

A. INADEQUATE ACADEMIC PREPARATION OF STUDENTS IN THE EARLY GRADES IN MATHEMATICS, SCIENCE AND ENGLISH

The years from age three to ten are a critical period in a child's cognitive development. Long term success in learning depends largely on a student's educational experience during this span.[21] It is during this period that children develop greater facility in intellectual problem solving and abstract thinking.[22] Unfortunately, many New York City students do not receive the best educational experience during this critical period.

The elementary and junior high schools are organized into 32 community school districts (CSDs) each administered by a community school board (CSB). Districts have to make tough decisions regarding budget priorities. Districts also vary in their ability to secure outside financing for math and science programs. The ones that are more proficient and persistent in writing grant proposals are more likely to obtain such financing. As what may be considered a worst case example: Chancellor Crew suspended the Board members of CSB 5 in March 1997 on the grounds that education was not their priority. The Chancellor discovered that the science mini-school in the district, for example, had no science supplies. Additional issues that impact on the quality of math and science education are discussed below.

1. NO CONSISTENT CURRICULA

One problem impeding achievement at the elementary and junior high school levels is the inconsistency of the curriculum. Curriculum goals are not clearly defined and actual course content varies from district to district and from grade to grade within the same district. The right balance between a rigorous core curriculum (including English, mathematics and science) and

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[21] Carnegie Corporation of New York, *Years of Promise: A Comprehensive Learning Strategy for America's Children*, 1996, p. 1.

[22] Ibid.

enough flexibility to allow individual schools to be able to provide the variety of programs that different students need must be found. PS 67, in District 12 in the Bronx, has improved its performance using a core curriculum that allows teachers to build on what students learn from one grade to the next. A recent Educational Priorities Panel study of ten schools that improved performance enough to be removed from the State's list of under performing schools revealed that these schools achieved success by building on what students learned from one grade to the next.[23]

Most of of the highest achieving school systems around the world teach a core curriculum in the first six grades.[24] By contrast, math and science curricula in the U.S. lack coherence when compared to that of many other countries around the world.[25] In the U.S., students in grades 1 through 8 are exposed to a huge number of fragmented topics - "teachers ... often cover something of everything and little of any one thing." As a result, a 4th grade teacher does not necessarily know what material was covered in the 3rd grade. What is true for the country as a whole is also true in the City's public schools.[26] Because guidelines are so vague, there is great variation in the content of what is taught from one school to another and even one class to another. This lack of consistency makes it difficult for conscientious teachers to adhere to a rigorous curriculum. They must try to fill the knowledge gap for some students by slowing the class down, or, continue to move it forward knowing that some students will fall even further behind. Either approach is harmful to students. It makes it hard for less prepared students to learn challenging material, while advanced students may lose interest because of the boredom of repetition. The Carnegie Task Force on Learning in the Early Grades recommended the adoption of rigorous performance standards that specify what each elementary school student should learn in all subject areas.[27] One element of the New York State Education Department's overall strategy of raising standards is "developing a core curriculum for all grade levels so students are successful at State established levels of performance..."[28]

The impact of curriculum inconsistency is amplified by the high mobility of the students. If a student transfers from one school to another in the middle of the year any inconsistency in the curriculum may have a devastating impact. For New York City, during the 1995-1996 school

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[23]Educational Priorities Panel, *Getting off the List: School Improvement in New York City*, November 1996.

[24]Education Week, *U.S. Students About Average in Global Study*, November 27, 1996, p. 1.

[25]Education Week, *Math, Science Curricula Said to Fall Short*, October 16, 1996, p.1.

[26]Comptroller's Office interview with Ron Wilson, United Federation Of Teachers, March 5, 1997 and Jeffery Litt, Principal of PS 67, Bronx, March 12, 1997.

[27]Carnegie Corporation of New York, Op. Cit., p. 5

[28]Testimony of James Kadamus, Deputy Commissioner, Elementary, Middle, Secondary and Continuing Education, New York State Education Department, before the Committee on Education and the Workforce, U.S. House of Representatives, May 5, 1997.

year, 25.1 percent of high school students, 17.3 percent of middle school students, and 19.2 percent of elementary school students were not in the same school for the entire school year.[29] In individual schools the mobility rate can be as high as 50 percent. This measure of mobility has been steady over the last several years. Some schools have a highly mobile population because of students from families in temporary housing such as shelters. Families also move from one borough to the next as they change apartments or buy homes.

Up until the end of SY 1994-95 the only standards in our school system were based on minimum competency tests provided by the State Education Department. In an attempt to improve this situation the Board introduced the Curriculum Frameworks in SY 1995-96. The Curriculum Frameworks was a broad outline of content and skills to be used by districts and schools as a guide for the development of curricula. It was not specific enough to provide a common specific core of knowledge. For example, one of the 5th grade mathematics goal is "explore complex numbers by gathering statistics from real world situations." Acknowledging the need to do more, Chancellor Crew announced the adoption of the New Standards in December, 1996, superseding the Curriculum Frameworks.[30] The New Standards were developed by the National Center on Education and the Economy in collaboration with the Learning Research and Development Center of the University of Pittsburgh. The New Standards set tougher performance standards and provide a detailed description of how well students should know what they are taught and ways in which their performance is demonstrated. The New Standards make a distinction between content standards and performance standards. Content standards specify: "what students should know and be able to do"; performance standards go to the next step to specify "how good is good enough."[31] They are defined for elementary, middle and high schools in English language arts, mathematics, science and applied learning[32]. The Board adopted the English language arts standards in the Fall of 1997 and the mathematics standards in the Fall of 1998.

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[29]Board of Education, Office of Assessment.

[30]The New Standards are nationally recognized and were developed with input from the national professional organizations for the individual disciplines and international experts on education, from countries including Australia, Belgium, Canada, Denmark, Britain, Finland, France, Germany, Japan, the Netherlands, New Zealand, Norway, Poland, Singapore, Sweden, and Switzerland.

[31]National Center on Education and the Economy and the University of Pittsburgh, *New Standards - Performance Standards: Vol. 1 Elementary School*, 1997, p. 3.

[32]Applied Learning focuses on the capability of the individual to apply knowledge gained in school and elsewhere to analyze problems and propose solutions, to communicate effectively and coordinate action with others. It connects the work students do in school with the demands of the 21st century workplace.

2. MATH PERFORMANCE

Performance in math at the elementary and junior high school levels is steadily improving. Table 3 shows that there have been significant improvement in all grades, 3 through 8, taking the California Achievement Test in Mathematics (CAT-5). City-wide, the percentage of general education and resource room students from grade 3 through 8 performing at or above grade level in math has improved from 49.9 percent in 1994 to 60.4 percent in 1997. Even though test scores have improved for all students for all grades over the last 3 years, there has been a consistent problem in the upper grades that persists despite this improvement, see Table 3 and Figure 1. As

Table 3, Citywide California Achievement Test (CAT-5) Math Test - Grades 3-8.

Grade	Percent at or Above Grade Level (50th Percentile)			
	1994	1995	1996*	1997
3	53.2	57.0	60.6	63.8
4	51.0	60.7	64.7	66.6
5	56.9	56.8	64.9	62.9
6	50.6	52.1	63.3	59.8
7	43.7	45.3	47.6	53.0
8	42.9	46.7	56.6	54.9
Citywide	49.9	53.3	59.7	60.4

Source: Board of Education City of New York

* Note. Estimated, the scores of students who would not have been tested in 1996 if the LEP exemption policy had been in effect have been deleted to allow comparison with 1997 results.

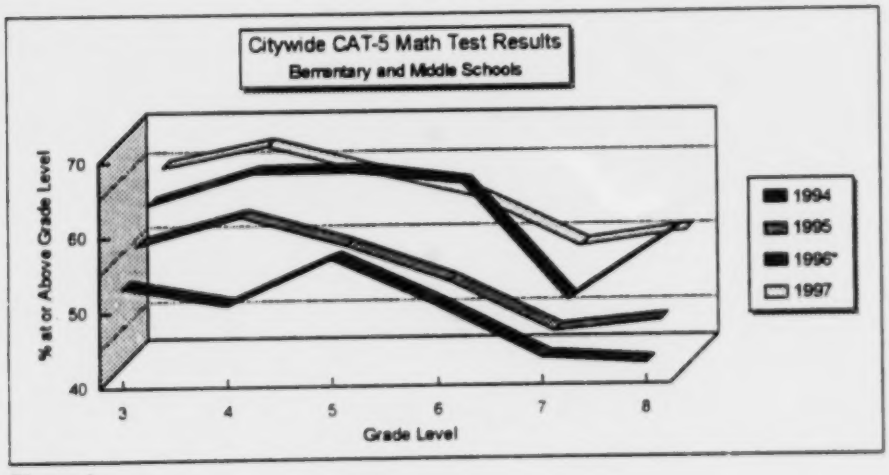

Figure 1

* See Note to Table 3, above

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an example of the overall decline in student performance between 5th and 7th grade: for 1997, student performance initially rose from 63.8 percent to 66.6 percent in the 4th grade and then fell to 54.9 percent in the 8th grade. Figure 1 shows a snapshot of math performance for each year, starting in 1994 through 1997 for grade 3 through grade 8. A marked decline can be seen as early as the 4th grade for the years 1995 and 1997, and 5th grade in 1994. Figure 2 shows the performance of various cohorts starting out in 3rd, 4th, 5th and 6th grade in 1994 and 3rd grade in 1995. Figure 2 shows essentially the same fall off in students' performance. This phenomenon is consistent with national trends and the reasons are unknown, however, some educators suggest that students are not being offered the more challenging curriculum that the tests cover in the later grades.

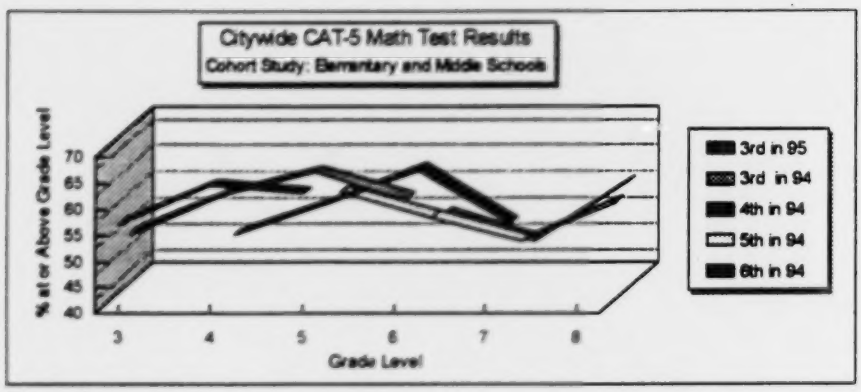

Figure 2

3. SCIENCE PERFORMANCE

The Elementary Science Program Evaluation Test (ESPET), administered to fourth grade students, is used by the State to assess science programs from kindergarten through fourth grades. The test has two sections; an objective section and a manipulative skills section. The objective section measures mastery of content and skills of the State elementary science syllabus and the manipulative skills section evaluates the ability of students to observe, draw conclusions, and make inferences and generalizations. ESPET test scores have been low for many years. When these scores are ranked with the other school districts in the State, New York City consistently ranks in the first quartile. Therefore, New York City public school system students are not properly prepared for the content and skills required nor does it empower students with the ability to observe, draw conclusions, and make inferences and generalizations required by the State elementary school science syllabus. Board personnel noted that in some districts science is not taught until 4th grade, when students are required to take the ESPET test. Table 4 shows that the scores, in all areas, for 1994 through 1996 range from 60.6 percent to 68.6 percent.

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Table 4, New York City Fourth Grade Elementary Science Program Evaluation Test (ESPET)

Material Covered by Test (Maximum Score)	1994		1995		1996	
	Average Raw Score	Percentage Score	Average Raw Score	Percentage Score	Average Raw Score	Percentage Score
Content (29)	19.9	68.6	17.9	61.7	18.3	63.1
Skills (16)	9.7	60.6	10.0	62.5	10.0	62.5
Manipulation (40)	27.0	67.5	27.4	68.5	27.4	68.5

Source: NYSED

4. ENGLISH AND READING PERFORMANCE

In order to excel in almost any subject area, a student must have a good command of the English language. Science is laden with technical terms that present major challenges to a student who is weak in English. Of course, poor reading skills make it difficult for students to solve word problems that require good comprehension. Take, for example, the following problem from a sixth grade Citywide math test:

> What additional information is needed to solve this problem? Kim's parents own a farm. The total area of their farm is 10,000 square meters. If the length of the vegetable garden is 100 meters, how much fencing is needed to enclose the garden?

A student with poor comprehension skills will have extreme difficulty understanding these types of problems.

There have also been modest gains in student reading scores of students from grades 3 through 8 in the 1997 City-wide test. Nevertheless too many students are still reading below grade level. Table 5 shows the results for the new reading test, CTB-R (which replaces the Degrees of Reading Power tests), in the elementary and junior high schools. Only in the 4th grade do our public school students score above the national average. Overall, our students perform just below national norms. Reading scores follow the same trend as math scores. Scores increase initially then decrease in the higher grades, with some recovery in grades 7 and 8. Figure 3 shows this trend.

Table 5. Comparison of 1995 - 1997 Reading Test Results.

Grade	Percent at or Above Grade Level (50th Percentile)		
	1995 Equivalent D.R.P.[1]	1996 CTB-R	1997 CTB-R
3	41.2	42.5	49.3
4	49.3	46.6	54.1
5	40.2	42.3	47.2
6	38.7	36.8	42.6
7	39.2	38.4	45.2
8	43.7	42.3	44.7
Citywide	42.1	41.6	47.3

Source: Board of Education City of New York

[1]The actual test taken in 1995 was the DRP. Adjustments were made to the 1995 DRP scores to make them comparable to the 1996 and 1997 CTB-R scores.

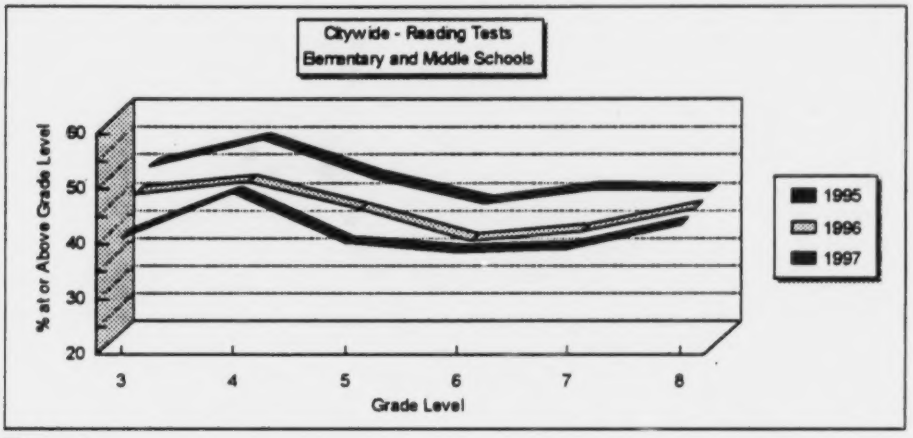

Figure 3

A key to improving student reading scores is to focus on professional development. School districts that focus on student literacy and professional development can have a marked impact on reading scores. For example, District 2 in Manhattan has successfully improved reading scores. District 2 currently ranks second, City-wide, in reading scores for grades 3 through 8. Its reading scores have been increasing since the 1980s. Almost 69 percent of students in District 2 read at or above grade level. The district also had one of the greatest increases in reading performance between 1996 and 1997 for districts that performed above 50 percent in 1996. Administrators at District 2 attribute this improvement in reading scores to its focus on literacy and professional development - "We believe you need to improve teaching skills to improve learning. The work

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we have done to improve teaching skills are responsible for the improved reading scores."[33] Teachers are required to attend workshops throughout the school year, and in the summer, on a consistent basis. The workshops are conducted by a variety of professional developers, including consultants as well as in-house trainers. The State Department of Education has identified reading and literacy in the early grades as a priority in implementing its plan for higher student achievement.[34]

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[33]Comptroller's Office interview with Andrew Lackman, Deputy Superintendent of District 2, April 9, 1998.

[34]Testimony of James Kadamus, Deputy Commisioner, Elementary, Middle, Secondary and Continuing Education, New York State Education Department, before the Committee on Education and the Workforce, U.S. House of Representatives, May 5, 1997.

B. SHORTAGE OF MATH AND SCIENCE PROFESSIONALS

Of course, success of the Initiative is dependent upon an adequate number of qualified teachers. What happens in the classroom is a key to the success of any program intended to create improvement in the system. A study published in the Harvard Journal of Legislation shows that resources directed at attracting and developing qualified teachers produce greater gains in student performance than other expenditures of education funds. One key component of improved student performance on the Regents-level examinations is proper initial preparation of teachers to teach Regents-level classes and ongoing teacher support from the districts and the Board. This means investing in much better teacher preparation and professional development.[35] Only with a highly qualified and committed teaching staff can we ensure the success of our public education system.

1. TEACHERS WITHOUT PERMANENT CERTIFICATION

Our schools have suffered teacher shortages for many years. In total, almost 10,000 teachers in New York City teach with temporary licences and do not qualify for teaching certificates.[36] The rest of the State, with approximately twice the number of students as New York City, has only 1,185 teachers teaching with temporary licenses. Many teachers issued temporary licences fail the State certification exam in the liberal arts and sciences while others lack necessary education courses or other requirements.

The Office of Teacher Certification (OTC) of the New York State Education Department (NYSED) issues permanent certificates to teachers who possess a graduate degree and are qualified in the area for which the certification is issued. Provisional certification is issued for five years to teacher education graduates with a bachelor's degree, or approved equivalent, working on their master's degree. Temporary licenses are issued to teachers who are not yet certifiable because they need to complete certain specialized courses.[37] Because of the great shortage of math and science teachers, OTC is more flexible in approving temporary licenses for public school districts, such as New York City, that demonstrate difficulty recruiting enough teachers. These uncertified teachers can be employed by the Board if a staff development plan is created to help the teacher become certified.[38] Another result of persistent teacher shortages is that teachers may be assigned to teach subjects not covered by their certificate or license. For example, teachers with a history certificate may be assigned to teach science. This situation is largely driven by a

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[35]Darling-Hammond, L., *The Quiet Revolution. Rethinking Teacher Development*, Educational Leadership, Vol. 53 No. 6 March 1996, p. 5.

[36]New York State Board of Regents, *Regents Task Force on Teaching*, June 12, 1998, p. 10.

[37]This is significant because no other profession allows individuals to practice without a license.

[38]United Federation of Teachers, *Nut and Bolts: Building a Career*, 1996-1997, p. IV-8.

shortage of math and science teachers. Math and science are some of the areas with the greatest need for certified teachers.

Many teachers enter the classroom not just without State certification but also with little or no experience. An estimated 950, or 14.2 percent of junior high and high school math and science teachers were not certified in the SY 95-96. Also, 1,532, or 22.8 percent of all math and science teachers had two years or less experience in the 95-96 school year, see Table 6 and Figure 4. The state will grant temporary licenses to teachers in a particular district if a shortage of teachers is

Table 6, Experience of Math and Science Teachers

Experience	Number of Teachers
0-2 years	1,532
3-5 years	1,097
6-9 years	897
10-14 years	805
15-19 years	493
20-24 years	551
25-29 years	977
>29 years	370

Source: Board of Education

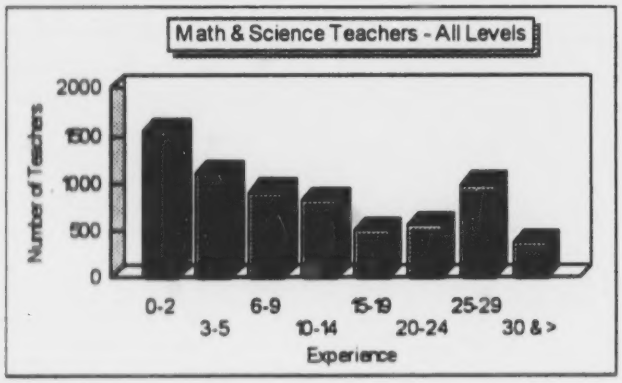

Figure 4

demonstrated. Upon entering the schools these teachers are most in need of professional development and supervisory support. UFT and Board of Education representatives as well as the Regents Task Force on Teaching have concluded that, because of seniority or other factors, newly hired teachers may be placed in the worst schools with no mentorship and little professional development, where they "sink or swim, - many sink."[39] This strategy does not work. It leads to high attrition rates and low teacher effectiveness.[40] Mentorship can make the difference between a teacher deciding to leave teaching or not. The South Carolina Legislature, mindful of the critical importance of this issue, mandated that all school districts establish intensive mentoring programs for new teachers.[41]

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[39]New York State Board of Regents, *Regents Task Force on Teaching*, Op. Cit.

[40]Education Week, *Teaching Quality*, Vol. XVI, January 22, 1997, p. 41

[41]Steinberg, Jacques, The Changing Face of Teachers, New York Times - Education Life Supplement, April 5, 1998, Section 4A, p. 31.

The number of science courses taken by a science teacher correlates to the development of a positive attitude toward science in a student.[42] Teacher effectiveness has also been found to be positively related to the number of education courses taken, student teaching grade and experience teaching.[43] More than 2,600, 39.1 percent, of the 6,722 math and science teachers have 5 or less years experience, 1,532 of them, or 22.8 percent have two years or less.

During the fiscal crisis in 1975, more than 12,000 teachers were laid off. This included hundreds of math and science teachers. Because there must be a teacher in every classroom, the shortage of math and science teachers can be measured best by using the number of uncertified teachers that the Board employs.[44] Figures 5 compares the number of uncertified math teachers employed by the Board between SY 92-93 and SY 96-97. Figure 5 also shows the assignment of math teachers in the school districts[45] as well as high schools. Figure 5 shows that there was a slight decrease in the number of uncertified math teachers employed in the school districts between SY 92-93 and SY 96-97. Out of a total of 1,411 math teachers employed in the school districts, 293, or 20.8 percent, were uncertified in SY 96-97 down from 316, or 23 percent, in SY 92-93. The number of uncertified math teachers in the high schools remained virtually the same during that period; 294, or 12.9 percent, of a total of 2,278 in SY 96-97, compared to 293, or 14.2 percent, in SY 92-93.

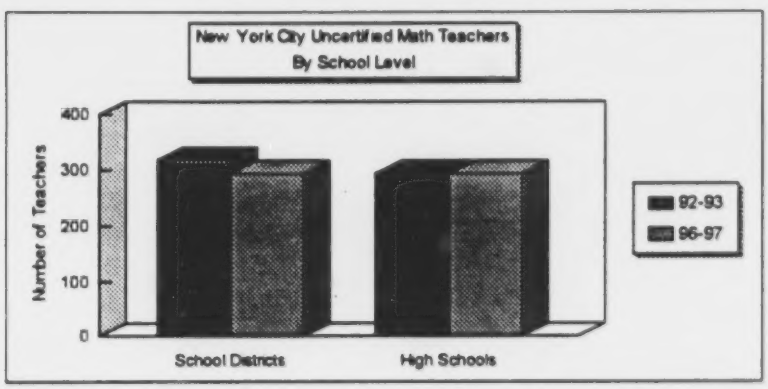

Figure 5

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[42]Druva, Cynthia A., Anderson, Ronald D., *Science Teacher Characteristics by Teacher Behavior and By Student Outcome: A Meta-Analysis of Research*, Journal of Research in Science Teaching, Vol. 20, No 5, p. 476.

[43]Ibid., p. 473.

[44]Educational Priorities Panel, *Swimming Upstream: The First-Year Experience of Teachers Working in New York City Public Schools*, May 1995, p. 7.

[45]The teachers in the school districts are elementary and junior high schools teachers.

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The situation is vastly different for science teachers, particularly in high schools, see Figure 6. In the school districts, the number of uncertified science teachers increased dramatically, from 147, or 15.7 percent, out of 938, in SY 92-93 to 308, or 30 percent, out of 1096, in SY 96-97. This translates into a 110 percent increase, significantly more than doubling, in the number of uncertified elementary and junior high school science teachers during this 4-year period. The number of uncertified science teachers also more than doubled in the high schools, jumping from 261, or 16.5 percent, out of 1,583, in SY 92-93 to 645, or 30.6 percent, out of 2,106, in SY 96-97. This represents a 147 percent increase in the number of uncertified high school science teachers during this 4-year period. According to the Board's math and science coordinator, of the science subjects, physics has the most severe shortage of certified teachers.[46] Hence, the Board had been unable to find certified math and science teachers in a time when there is increased need. As mandates force the creation of smaller class sizes and therefore more classes, the shortage of certified math and science teachers will only worsen unless some changes occur.

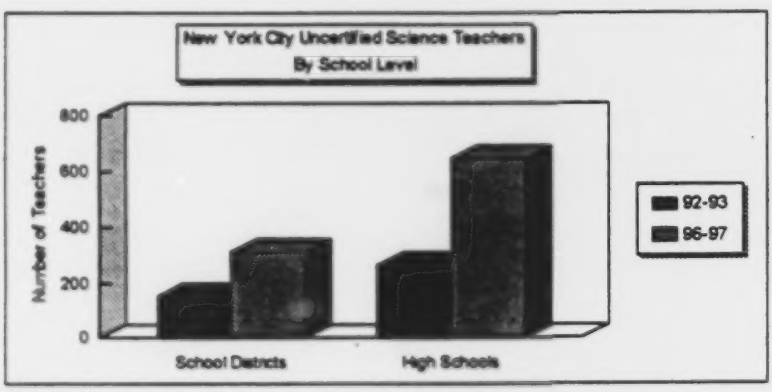

Figure 6

When compared with Long Island school districts and the rest of the State, the New York City public school system's shortage of certified math and science teachers is much worse. Our school system has almost three times as many uncertified math teachers as the rest of the State, even with an improvement in the percentage of uncertified math teachers in the City schools from 17.7 percent in SY 92-93 to 15.9 percent in SY 96-97. See Table 7 and Figure 7.

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[46]Comptroller's Office interview with Anthony Viteritti, Science Coordinator, Board of Education, February 14, 1997.

Table 7, Uncertified* Math Teachers in New York City ,Long Island, and the Rest of New York State

School District	Percentage Math Teachers Uncertified	
	SY 1992-93	SY 1996-97
New York City	17.7	15.9
Long Island	3.8	4.7
New York State**	5.4	5.9

Source: Data on New York City from the Board of Education, other data from NYSED.
* Includes teachers holding a temporary license and teachers certified in other subjects
** Excluding New York City

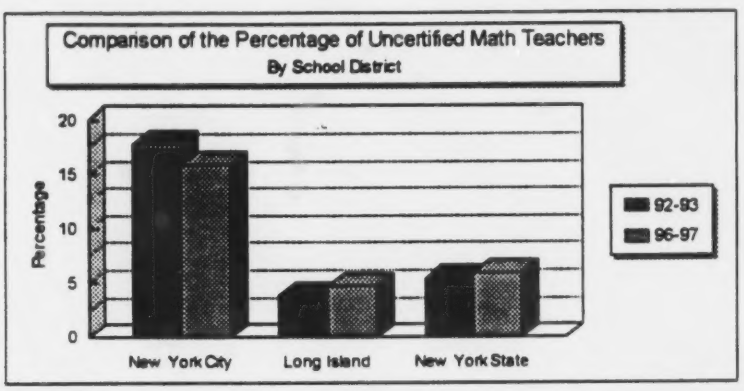

Figure 7

In SY 92-93, 16.5 percent of the science teachers employed by the Board were uncertified. This number, almost three times that of the rest of the State and the Long Island districts, nearly doubled in SY 96-97 to 30.4 percent. This represents nearly 1 in every three science teachers, see Table 8 and Figure 8.

Table 8, Uncertified* Science Teachers in New York City , Long Island, and the Rest of New York State

School District	Percentage Science Teachers Uncertified	
	SY 1992-93	SY 1996-97
New York City	16.5	30.4
Long Island	5.0	4.7
New York State**	5.9	6.7

Source: Data on New York City from the Board, other data from NYSED.
* Includes teachers holding a temporary license and teachers certified in other subjects
** Excluding New York City

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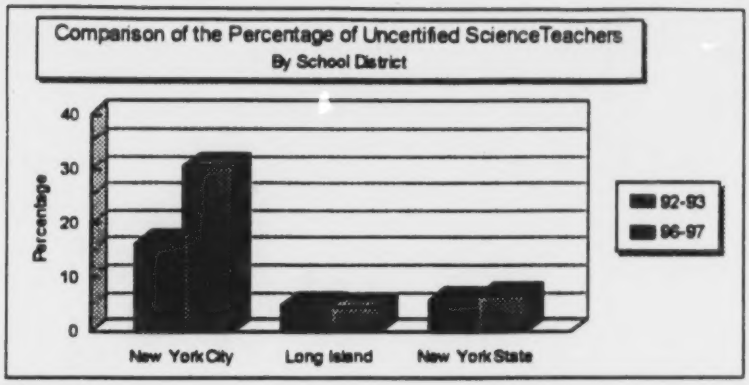

Figure 8

The Board had made significant improvement in reducing the overall percentage of uncertified teachers in its ranks. In SY 1992-93, 14.8 percent of all teachers were uncertified, by SY 1996-97 that number decreased to 12.3 percent. However, the corresponding data show the situation to be worse for math and science teachers. For math teachers, the portion of uncertified teachers decreased from 17.7 percent in SY 1992-93 to 15.9 percent in SY 1996-97 - still a substantial gap between math teachers and the total population. For science teachers the situation has to be considered a crisis; the portion of uncertified teachers *increased* from 16.5 percent in SY 1992-93 to 30.4 percent in SY 1996-97.

2. LOSS THROUGH RETIREMENTS

The shortage of certified teacher has been exacerbated by the retirement of hundreds of senior math and science teachers who opted to take advantage of early retirement packages offered by the Board.[47] The first of the recent early retirement packages occurred in 1991: 333 math and science teachers retired, 221, or 66 percent, of them from high schools. The next significant years were 1995 and 1996: in 1995, 316 math and science teachers retired of which 179, or 57 percent were from high schools; in 1996, 240 math and science teachers retired of which 162, or 68 percent were from high schools. In all, 1,074, or approximately 12.3 percent of all the math and science teachers retired between 1990 and 1997. This exodus has significantly affected the corps of math and science teachers. Figure 9 shows that the majority of retirees are consistently from high schools. Figure 10 shows that significantly more science teachers than math teachers have been lost due to retirements.

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[47]These packages were offered to induce older, more experienced teachers to retire in order to cut personnel cos's - because teacher salary is based on seniority. The Board was a prime target of budget cuts between FY 1994 and FY 1996.

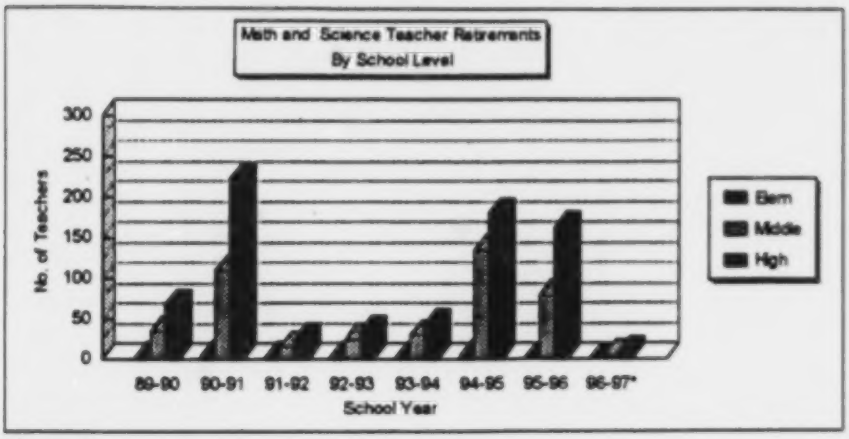

Figure 9

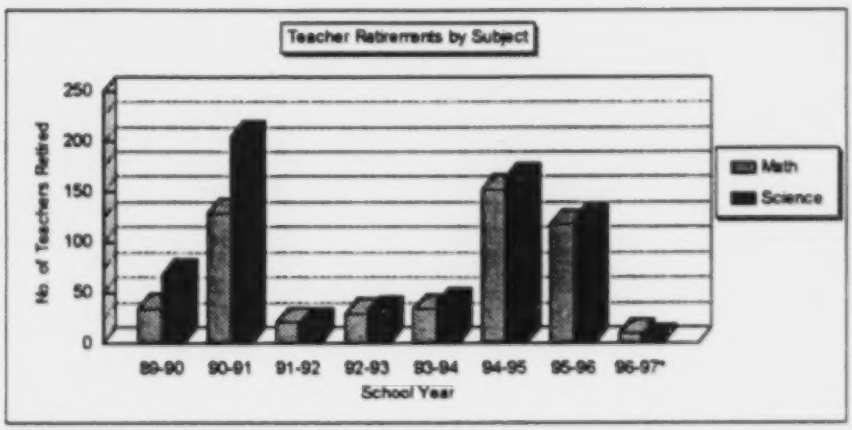

Figure 10

3. INADEQUATE RECRUITMENT

With such large numbers of early retirements the Board had to dramatically increase its hiring of replacement teachers. A significant increase in hiring did not occur until 1995 when the Board hired 427 math and science teachers, see Table 9 and Figure 11. In 1996 the number of math and science teachers hired increased dramatically to 853. This cycle of early retirement and subsequent hiring of new teachers drained the Board of experienced teacher-mentors and increased the ranks of inexperienced teachers.

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Table 9, Total Math and Science Teachers Hired Annually

	School Year				
	1992-93	1993-94	1994-95	1995-96	1996-97
Math	185	180	181	179	341
Science	144	154	212	248	512
Total Hired	329	334	393	427	853

Source: Board of Education

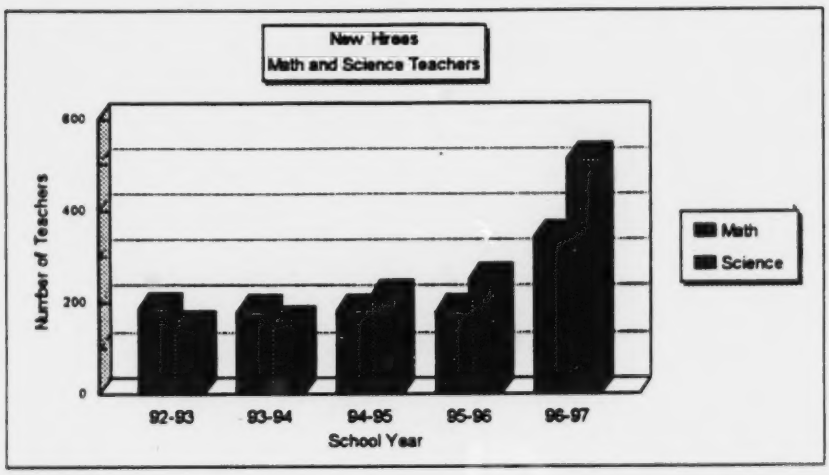

Figure 11

In the elementary schools, teachers are classified as common branch, because they are not required to have a specialization in any subject area. According to the United Federation of Teachers (UFT)[48] these teachers typically do not have a math or science background and, therefore, may not know how to teach math or science.[49] The New York State Education Department requires completion of only 6 semester-hours of college level credits each in math and science. The level of credit is not specified. Therefore, a teacher with a GPA of 2.0 in two freshman or sophomore level courses may be certified by the State to be in the classroom providing the math and science foundation for scores of students in that critical stage of their educational development.

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[48]Comptroller's Office interview with Jean Delfiner, Science Representative, UFT, December 16, 1996.

[49]The State requires a minimum of 6 credits in math and 6 credits in science for common branch certification.

Teachers at the junior high school level are required to have significantly more training in math and science than their common branch counterparts. The New York State Education Department (NYSED) requires 36 semester hours of study in the concentration for which the license is issued. This seems a sufficiently rigorous preparation for a teacher who wants to concentrate on math or science.

While new teachers may have been instructed in the latest teaching methodologies and bring energy and enthusiasm to the classroom, questions have been raised about the effectiveness of their preparation, particularly at the CUNY colleges. Many of the teacher preparation colleges are doing a poor job of preparing prospective teachers in math and science. According to NYSED, approximately 50 percent of New York City's public school teachers obtained their degrees from CUNY. Of the prospective teachers from CUNY who took the Liberal Arts and Science Test, needed for certification, in 1996, 38 percent failed.[50] Only 5 percent from the State colleges and 13 percent from independent universities failed the exam.

For talented teachers to decide to teach and to remain in teaching, they must perceive opportunities for professional growth, advancement, and financial rewards.[51] Many math and science majors who would be well qualified as teachers choose to pursue more financially rewarding careers. Another serious obstacle to remedying the shortage of math and science teachers has been the Board's poor hiring practices. The process has been described as "....delayed, tortuous and uncertain."[52] The City has additional licensing requirements that take candidates more than a year to complete and add little useful information to the State licensing system.[53] Hiring decisions are sometimes so protracted that good candidates go elsewhere.[54]

The Board has been improving its hiring practices and attracting more teachers. It conducted two successful new "Teach New York" job fairs in April and May 1997. The job fairs were coordinated with representatives from the State Education Department and the UFT. The Board

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[50]The Liberal Arts and Science Test (LAST) assesses knowledge and skills in five areas: scientific and mathematical processes, historical and social scientific awareness, artistic expression and the humanities, communications, and written expression. Although the majority of the perspective teachers who take the LAST exam at a CUNY college are CUNY graduates, some are not. A portion of these individuals graduated from other colleges and are fulfilling some license requirement at the CUNY college when they take the exam.

[51]Darling-Hammond, L., Scalan, E.M., *Who Teaches and Why: Dilemmas of Building a Profession for Twenty-first Century Schools* (1996) in Handbook of Research on Teaching Education, Second Edition, New York: Simon and Schuster Macmillan., p. 69.

[52]Comptroller's Office interview with Linda Darling-Hammond, Co-Director, National Center for Restructuring Education and professor at Teachers College, Columbia University, May 22, 1997.

[53]Darling-Hammond, Linda, *A Qualified Teacher for Every Child: The Pathway to Meeting New Standards for Students in New York State*, National Commission on Teaching and America's Future, p. 20.

[54]Ibid.

now conducts recruitment seminars at 27 metropolitan area college campuses for seniors in teacher preparatory programs. The Board has also been visiting districts and high schools to review the education plans of their uncertified teachers to ensure that uncertified teachers are progressing toward State certification and City licensure. The Board has initiated or proposed the use of technology to improve recruitment and licensing. The Board is distributing citywide postings, applications and forms via E-mail. It has also implemented electronic data transfer with the New York State Division of Criminal Justice Services to check fingerprint records. In the future, applications and transcripts will be scanned and available for distribution. Scanning will streamline applicant processing and improve the Board's management of applicant data and records. For SY 1996-97, the Board hired a total of 341 math teachers and 512 science teachers, double the amount hired in the previous year. As indicated previously, the greatest need has been for science teachers, because they account for the larger number of retirees.

The latest effort to recruit teachers by the Board is an innovative program to hire math and science teachers from Austria, where there is a surplus of qualified teachers. Under this trial program, a collaborative effort with the Department of Education at City College, graduates from undergraduate and graduate programs in math and science are offered a one year commitment for full time employment at high schools throughout the five boroughs. Austrian teachers are more thoroughly prepared than New York teachers. They major in two related subjects and must serve as an apprentice teacher for one year. The new teachers are required to take courses including English and local teaching methodologies at City College. The Board hired approximately 60 teachers in the Fall of 1998. Many of the teachers hired have majors in both math and science. If the program is successful the Board plans to take aggressive steps to expand.

Tuition Assistance and Scholarship Programs

The Board offers tuition assistance programs to prospective and current teachers for State certification in areas of special education. These assistance programs are however, mandated by the Jose P. stipulation and do not address shortages in math or science.[55] The tuition assistance programs consists of the Scholarship Program, the Loan Forgiveness Program and the Bilingual Special Education Teacher Training Program.

- The Scholarship Program provides full tuition reimbursement for participants in return for a commitment to State certification and service in a position in a shortage area.[56] In SY 96-97, there were 493 participants in the program and 976 had graduated since its inception. In SY 1997-98, 762 teachers participated at a cost of $6.93 million.

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[55]A court ruled in 1979 on a class-action lawsuit filed on behalf of a disabled student, Jose P., that the Board had failed to provide Jose P., and other students with services to which they were entitled. Compliance with the court order is on-going, with the Board devoting enormous resources annually.

[56]These areas are Special Education, Speech Improvement, Deaf and Hard of Hearing, Visually Impaired, School Psychologist, School Guidance Counselor and School Social Worker.

• The Loan Forgiveness Program recruits individuals not working for the Board but who posses State certification in bilingual special education shortage areas and who have an outstanding student loan. The Board assumes responsibility for loan re-payments up to a maximum of $4,000 annually for up to six years in exchange for a six-year commitment to teach in the shortage area. In SY 1996-97, 99 teachers participated at a cost of $215,710.

• The Bilingual Special Education Teacher Training Program was designed to provide first-year uncertified bilingual special education teachers[37] with tuition assistance in a master's degree program leading to certification in bilingual special education. The program currently has 90 participants. In SY 1996-97, 19 teachers participated at a cost of $48,716.

Once popular and effective national teacher incentive programs, such as the Urban Teacher Corps initiatives and the Master of Arts in Teaching programs, have been eliminated. These programs almost eliminated the hiring of unprepared teachers during the 1970s. The National Commission on Teaching and America's Future recommends providing incentives to recruit teachers for high need subjects and locations.[38]

Alternative Teacher Recruitment Programs

As the student enrollment in the public school rises fewer college students are entering the teaching profession causing alarm about the supply of teachers needed to meet the demand. Between 1988 and 1994, there was a shift in the sources of supply of newly hired teachers as schools hired larger proportions of first-time teachers and smaller proportions of transfers and re-entrants.[39] These factors helped foster the creation of hundreds of alternative teacher recruitment and training programs to help alleviate the teacher shortages through recruitment from non-traditional sources. Examples of these programs include:

- **Teach for America.** Founded in 1989, Teach for America recruits non-education majors to commit two years to teach in low-income urban and rural public schools. It has recruited, trained and assigned more than 4,100 graduates from Ivy League and other prestigious colleges. The program requires relocation and involves an extensive five-week residential summer institute. Teach for America makes a particular effort to recruit math, science and foreign language majors. These corps members fill secondary school positions. Liberal arts graduates can qualify for regular elementary school positions.

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[37]The areas are Spanish, Chinese and Haitian-Creole.

[38]The National Commission on Teaching and America's Future, funded by the Rockefeller Foundation and Carnegie Corporation of New York, is a blue-ribbon group of 26 public officials, business and community leaders, and educators who are broadly knowledgeable about education, school reform, and teaching. It is housed at Teachers College, Columbia University and is chaired by Governor James B. Hunt Jr. of North Carolina and directed by Linda Darling-Hammond, professor at Teachers College.

[39]U.S. Department of Education, National Center for Education Statistics, The Condition of Education 1996; Sources of Supply of Newly Hired Teachers.

- **Troops to Teachers.** The Department of Defense Troops to Teachers program was established in 1994 to facilitate the placement of military personnel, Department of Defense and Department of Energy civilian employees. The program improves education by providing mature, motivated, experienced and educated personnel to classrooms. One of the major objectives of the program is to help alleviate the teachers shortage, especially in math and science. Troops to Teachers provides referral and placement assistance. State support offices have been established in 20 states to assist participants with both certification requirements and employment leads.[60] By 1998, 2,600 participants had been hired in 46 states -26 in New York State, and 2,200 participants are in training programs in 47 states - 28 in New York State.

- **DeWitt Wallace-Reader's Digest Fund Pathways to Teaching Careers Program.** The DeWitt Wallace-Reader's Digest Fund, named after the founder of Reader's Digest, is a major national foundation focused exclusively on improving education and career development opportunities for school-aged children, especially young people in low-income communities. Its Pathways to Teaching Careers Program focuses on recruiting nontraditional candidates to the teaching profession. Over 40 colleges and universities participate in the program providing scholarships and other support services so that paraprofessionals, non-certified teachers and returning Peace Corps volunteers can pursue bachelor's or master's degrees or other requirements leading to full time teaching jobs. After completing their studies Pathways Scholars commit to teaching in low-income urban or rural public schools for up to three years. So far, Pathways has enrolled 2,200 Scholars.

4. INADEQUATE COMPENSATION

Our public school system has the highest teacher turnover rate in the State at 17 percent.[61] One reason for the high teacher turnover in New York City's public schools may be lower salaries. Many teachers have left the system for jobs in the suburbs and one potent reason they do so is to earn more money. Table 10 shows the disparities between median, minimum and maximum teacher salary surrounding counties and New York City for SY 1996-97. While there is little disparity among the school districts surrounding the City - less than $2,900, the disparity between the City and Suffolk County was an astounding $20,764. This means that Suffolk County teachers earn 44 percent more than their New York City counterparts, who often have to work under much more difficult conditions.

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[60]As of March 1998, the following state offices have been established: AL, AZ, CA, CO, FL, GA, IL, KY, LA, MS, NJ, NC, OH, OK, SC, TN, TX, VA, WA AND WI.

[61]Eight community school districts and 2 high school Superintendencies have a teacher turnover rate of 20 percent or more. Most of these are in Manhattan and the South Bronx.

Table 10, Teacher Salary for New York City and Surrounding Counties

School District	Salaries[1], $ - 1996-97		
	Median	Minimum*	Maximum**
Suffolk	67,870	34,000	84,625
Nassau	65,025	37,406	83,249
Westchester	65,001	37,341	84,302
New York City	47,106	28,749	60,000

Source: New York State Department of Education

[1]Does not include fringe benefits.

* Numbers are actually 5 percentile, only 5 percent of teachers make this amount or less.

** Numbers are actually 95 percentile, only 5 percent of teachers make more than this amount.

New York City public school teachers, as with the rest of teachers in the State, are not paid based on performance, but solely on seniority and college courses completed. This is based on union benefits won since 1962 when the first teacher collective-bargaining contract was signed in the City.[62] At that time, the majority of teachers were poorly paid and subject to patronage hiring and other inequities. New York State laws now provide teachers with protection from these conditions. Nationally, teachers who do better in college and are rated higher by their principals leave the profession at higher rates than lower performing teachers.[63] New hires who enter teaching with little preparation are paid at the same level as those who enter with highly developed skills. Furthermore, teaching pays less than other occupations that require a college degree, see Figure 12. The National Commission on Teaching and America's Future in concluding that these conditions "... maintain a status quo in which knowledge and expertise have little currency," recommended that teachers be rewarded for knowledge and skill.[64]

In the 1960s, women had few professional opportunities and therefore gravitated to teaching. Today, women are no longer a captive labor force, but have more abundant career options, such as law, accountancy, medicine, engineering, etc..[65] Competition in the labor market for college graduates is expected to grow more intense as economic growth in knowledge related fields

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[62]Toch, Thomas, et. al., *Why Teachers Don't Teach*, U.S. News and World Report, February 26, 1996.

[63]Comptroller's Office telephone interview with Ann Weaver-Hart, Dean of Graduate School, University of Utah, February 26, 1998.

[64]National Commission on Teaching and America's Future, *What Matter Most: Teaching for America's Future*, September, 1996, p. 23.

[65]Darling-Hammond, L., Scalan, E.M., Who Teaches and Why: Dilemmas of Building a Profession for Twenty-first Century Schools (1996) in Handbook of Research on Teaching Education, Second Edition, New York: Simon and Schuster Macmillan., p. 69.

continues and the number of college-age youth declines.[66] Furthermore, those teachers who leave teaching go into other careers, with a declining number returning to teaching.

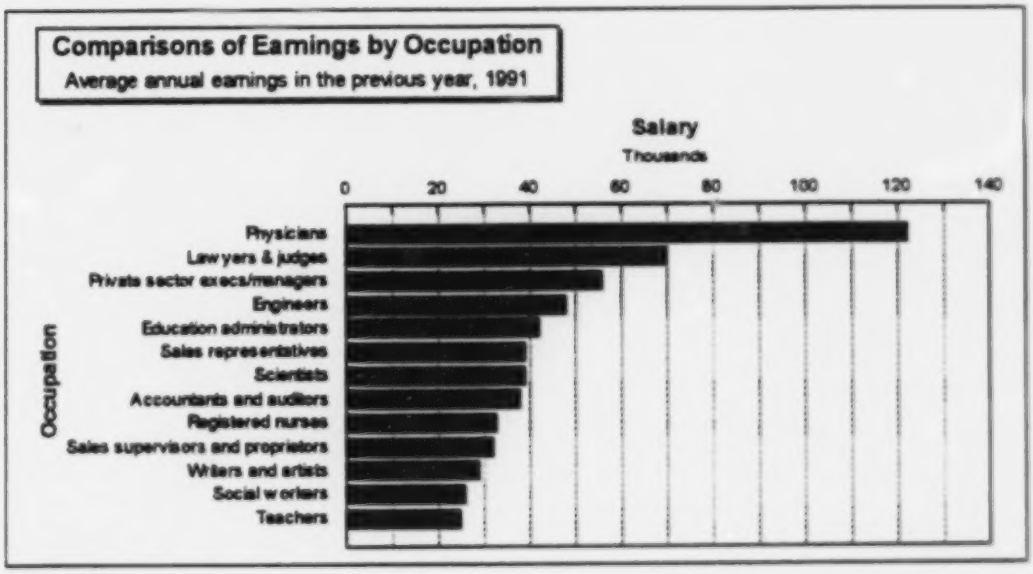

Figure 12

Source: National Commission on Teaching and America's Future, *What Matter Most: Teaching for America's Future*, p. 13.

[66]Ibid. p. 79.

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C. THERE IS A SHORTAGE OF LABORATORY SPECIALISTS

Laboratory specialists are licensed professionals who prepare material and set-up the equipment necessary to perform laboratory experiments. They handle dangerous chemicals and they may teach students and teachers how to use specialized and expensive equipment. Their preparatory work frees the teacher to focus on guiding the students through the experiments. Laboratory specialists are therefore critical to the operation of an effective pedagogical laboratory facility. The National Science Teachers Association (NSTA) recommends laboratory assistants for both middle and high schools.[67] According to the NSTA a competent student can act as the laboratory assistant at the middle school level. But in the high schools, the NSTA recommends a paraprofessional with responsibilities beyond set-up and clean-up, such as maintaining community contacts and researching resources.

Students suffer when schools have an insufficient number of laboratory specialists. A shortage means that some schools can't make full use of the laboratory and may mean less effective scientific training. It may increase the exposure of students and teachers to unsafe conditions and cause more wear on equipment.

Twenty three years after the fiscal crisis in 1975, the Board has only 47 percent of the laboratory specialists it had prior to the fiscal crisis. And, 15 years after the problem was first identified by a Comptroller's Office report there are still only 195 laboratory specialists, 9 percent less than in 1982.[68] Many of the laboratory specialists fired during the fiscal crisis were never replaced. In the 1960s, the Board determined the number of laboratory assistant positions to be filled by using a laboratory assistant index. This index took into account the number, type and level of science classes offered. When this index is used to calculate the number of laboratory specialists needed today, the result is just over double the current positions. To restore the number of lab specialists to 1974 levels the Board must hire approximately 215 more lab specialists.[69]

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[67]National Science Teachers Association, *A NSTA Position Statement: Laboratory Science*, http://nsta.org/handbook/labsci.htm

[68]New York City Comptroller's Office, *The State of Math and Science Education in the New York City School System*, June 15, 1982.

[69]While enrollment has been increasing since 1983, the student population in 1997 is similar to the enrollment in 1975 of approximately 1.1 million students.

D. TRAINING ISSUES

1. PRE-SERVICE ISSUES

Raising the level of performance expectation for the students must be accompanied by a similar expectation for the teachers. Good teacher performance starts with pre-service training.[70] A trilogy of quality teacher performance standards - teacher education program accreditation, initial teacher licensing, and advanced professional development - has recently been developed by three national professional bodies. Rigorous new standards for teacher preparation have been developed by the National Council for Accreditation of Teacher Education (NCATE). The Interstate New Teacher Assessment and Support Consortium (INTASC) created standards for initial teacher licensing.[71] The National Board for Professional Teaching Standards (NBPTS), the majority of whose Board members are accomplished teachers, established standards for certifying accomplished teachers.

New York State has not adopted these recent and more rigorous standards. Hence, teacher preparation in the State varies greatly, with some excellent programs and some that are of poor quality . Only four teacher education programs in New York State are professionally accredited by NCATE, none at CUNY colleges.[72] The other 108 New York State colleges with teacher education programs are accredited by the New York State Board of Regents.[73] The Board of Regents' status as an accreditation body is unique - it is the only State organization recognized as an accrediting body - and is based upon a reputation gained from past stellar performance. This status may not continue because of the Board of Regents reduced capacity to conduct reviews of colleges due to budget cuts starting in 1990.[74]

The New York State Board of Regents is in the process of reviewing teacher preparation programs. As indicated earlier, approximately 50 percent of New York City public school teachers are from CUNY colleges and these colleges have the worst performance of all the teacher preparation programs in the state. Table 11 shows the performance of prospective teachers matriculated at CUNY colleges in the various exams required for different types of certifications. Generally, individuals seeking certification in the common branch areas in grades pre-K through 6 or the academic subjects in grades 7 through 12 must complete the Liberal Arts and Science Test (LAST), the ATS-W and one of the Content Specialty Tests (CSTs). The LPA tests are given for certification in a specific language. Only 62 percent of the prospective teachers

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[70]Pre-service training refers to the preparation a teacher receives prior to entering the classroom.

[71]INTASC was formed from a consortium of 30 states and professional organizations.

[72]Comptroller's Office interview with Doris Garner, Staff Coordinator, Regents Task Force on Teaching, July 23, 1996.

[73]This practice is decades old and is approved by the United States Department of Education.

[74]Op. Cit., Comptroller's Office interview with Doris Garner.

from CUNY colleges that took the LAST in the 1995-1996 passed.[75] The pass rate was much higher for other institutions in New York State, 95 percent for SUNY college and 87 percent for independent institutions. Of the 112 colleges that have teacher training programs in the state two CUNY colleges, Medgar Evers and City College, had the 3rd and 4th worst pass rates, respectively, on the LAST test.[76] The performance of the CUNY colleges in the Written

Table 11, Performance of Prospective Teachers Testing From CUNY Colleges,* 1995-1996

CUNY Institution	Percentage of Students Passing Exam		
	LAST**	ATS-W***	CST/LPAs Grouped****
Baruch College	79	83	85
Brooklyn College	74	80	82
City College	40	48	76
College of Staten Island	78	85	95
CUNY Graduate School	78	40	100
Hunter College	83	88	93
Lehman College	57	66	93
Medgar Evers College	39	51	50
Queens College	83	88	89
York College	57	63	77
All CUNY	62	71	82
All SUNY	95	97	89
All Independent	87	91	87
All Institutions	83	89	86

Source: New York State Teacher Application Examinations Annual Institution Results Report, 1995-1996

* Although the majority of the perspective teachers who take the LAST exam at a CUNY college are CUNY graduates, some are not.

** Written Liberal Arts and Science Test

*** Assessment of Teaching Skills

**** The results of the Content Specialty Test and the Language Proficiency Assessments are reported together.

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[75] New York State Education Department, *New York State Teacher Certification Examinations: Annual Institution Results for the 1995-96 Program Year: Test dates: Nov. 18, 1995*, Feb 24, 1996; June 8, 1996.

[76] The two colleges that performed worse were: Boricus College with a pass rate of 24 percent, and Mercy College in the Bronx with a pass rate of 27 percent.

Assessment of Teaching Skills (ATS-W) was better than the LAST exam but was still significantly lower than for the SUNY and independent colleges.[77] The disparity between CUNY colleges and other colleges in the State was not as great for the CST and the LPA, however, the CUNY colleges still performed at a lower level than the other college groups.[78]

2. MAJOR PROFESSIONAL DEVELOPMENT PROGRAMS

Poor staff development is probably the biggest impediment to math and science education in the City's public schools. In 1988, the public school system produced 6,921 Regents endorsed diplomas, while in 1996 the number dropped to 5,512. We should raise expectations for both student and teacher performance. Many teachers have never taught Regents level courses, therefore it is crucial to train them to do so. In addition to the introduction of Regents requirements, teachers also need to learn new pedagogy. New national science education standards recommend inquiry-oriented investigations where students describe objects and events, ask questions, acquire knowledge, construct explanations of natural phenomena, test those explanations in different ways and communicate their ideas to others.[79]

The Board spent nearly $1.3 million on staff development for math and science teachers in FY 95-96. Of this, 88 percent, or $1.1 million, were reimbursable Title II funds.[80] This amounts to approximately $32 per teacher for math and science professional development for the approximately 41,200 elementary school, math and science teachers.[81] To expect teachers to rise to this higher level of performance without training and support is unrealistic. All teachers require ongoing in-depth professional development and support as well as adequate resources to stay abreast of new technology and new teaching techniques.

Investment in teacher development produces results. A study by a Harvard University researcher concluded that spending on more highly qualified teachers results in greater gains in

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[77]Given in elementary and secondary versions, the ATS-W assess knowledge of pedagogy in the following areas: student learning, instructional planning and assessment, instructional delivery, and professional environment.

[78]The CST exam does not include pedagogy or professional education but focuses exclusively on the certification subject. There are 21 CSTs: including elementary education, 11 languages other than English, social studies and 4 science specialties. LPAs are required for ESOL certificates and bilingual education extension certificates.

[79]National Research Council, *National Science Education Standards*, 1996 , p. 2.

[80]Title II Eisenhower National Program for Math and Science Education.

[81]This number, 41,200, includes all the common branch teachers in the elementary schools and all the math and science teachers in the middle and high schools.

student performance than any other use of school resources.[82] Another study conducted earlier in New York City found that teacher qualifications accounted for more than 90 percent of the variance in student reading and math scores.[83] This area of educational research is, however, plagued by controversy. One national study concluded that parents and peers, not teachers, have the greatest influence over a students classroom performance.[84] Even accepting that conclusion, the quality of teaching plays a significant role. Due to the influx of new teachers, many not fully qualified, and the new teaching standards, staff development will surely be one of the key elements of successful student outcomes.

Much criticism has been leveled at the Board's own professional development programs as well as its interaction with outside institutions that offer professional development to public school teachers. There appears to be a lack of coordination and support for these various programs. There is no coordination by the Board of private professional development programs with the Board's own activities. Another problem is that the Board fails to maximize the use of funds from outside sources. There is no designated personnel at the Board to act as a liaison and disseminate information to institutions. In May 1997, the National Science Foundation (NSF) threatened to withdraw its funding to the New York City Urban Systemic Initiative (NYCUSI) to improve math, science and technology in New York City public schools, see page 38.[85] This threat was in response to "an array of programmatic deficiencies" to the initiative.[86] One significant requirement for continued funding by NSF is the integration of the various reform programs to improve math and science education.

In the 1980s more money was spent on math and science staff development. Starting in 1983 then Comptroller Goldin added funding for curriculum development and math, science and computer education into the Board's budget. This amount had grown to an annual allotment of $43.1 million by FY 1989. The funding had been used for the continuation and expansion of programs which trained and retrained math and science teachers and computer science students. Additionally, funding had been used for the upgrading of science and computer supplies. New monies in FY 1989 went for the development of resource centers to complement the teacher training and retraining programs, and to a math and science remediation program targeted to

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[82]Ferguson, Ronald, *Paying for Public Education: New Evidence on How and Why Money Matters*, Harvard Journal on Legislation, Vol. 28:465, Summer 1991, p. 490.

[83]Armour-Thomas, Eleanor, et. al., *An Outlier Study of Elementary and Middle Schools in New York City: Final Report*, New York City Board of Education, 1989.

[84]Steinberg, Laurence, *Beyond the Classroom: Why School Reform has Failed and What Parents Need to do*, Simon and Schuster, 1996.

[85]The NYCUSI is a program to raise the understanding and performance of the students of the large urban districts throughout the country to world class standards. The NYCUSI program is funded by the NSF.

[86]Kennedy Manzo, Kathleen, *NSF Says Deficiencies Threaten Math-Science Grant in NYC*, Education Week, June 4, 1997, p.6.

bilingual and English as a second language (ESL) students. In the early 1990s this funding was discontinued.

a. SYSTEMIC INITIATIVES

As part of its nation-wide effort to improve math, science and technology education, the National Science Foundation (NSF) funds several programs in New York City. The two major programs are the New York City Urban Systemic Initiative (NYCUSI) and the New York State Systemic Initiative (NYSSI), both multi-year programs that aim at fundamentally changing the way that math, science and technology are taught in the public schools through professional development, curriculum improvements, partnerships with businesses and institutions of higher learning.

The NYCUSI program was formed as a collaboration with the Board of Education, the City University of New York, and the 40 school districts, including the high school superintendencies and the Chancellor's special district. The grant from the NSF is for $15 million over a 5 year period. Currently, in its fourth year, NYCUSI is undergoing significant restructuring and reform after changing leadership three times. NYCUSI is now poised to truly systematically change the way math, science and technology are taught and learned in our public schools.

The hierarchical status of NYCUSI has been elevated both at the Board and at CUNY. Additionally, five borough coordinators work with NYCUSI district liaisons, directors of instructions and staff developers. An Advisory Board and a plan for developing and disseminating systemic projects have been developed. The Advisory Board has subcommittees in key areas, including: Teacher Preparation, Exhibition (conferences, science fairs and expositions), web site development, Parent/Family/Community Engagement, 3D Sites (Development, Demonstration and Dissemination) and Leveraging Resources. In addition, the math and science-rich private sector is now being involved. Toward this end, the Board has distributed hundreds of RFPs for "Professional Services for Improving Instruction" and as a result has awarded 55 contracts.

The Chancellor has charged the NYCUSI to roll out the New Standards Project's Performance Standards for mathematics and science. District superintendents are required to submit a District Comprehensive Education Plan (DCEP) detailing the leadership role of NYCUSI in math, science and technology reform and are held accountable for performance.

NYCUSI efforts are concentrated on sustained professional development in both content and pedagogy.[87] Teachers and staff developers learn hands-on inquiry-based instruction through many nationally validated programs. Lead teachers serve as facilitators to other teachers within schools. Networking is facilitated by school administration, district personnel and NYCUSI in many forms.

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[87] New York City Urban Systemic Initiative, Program Effectiveness Review to the National Science Foundation, December 1997, p. 7.

common planning time, in-school workshops, after school meetings, cross district sessions, borough-wide and city-wide workshops, Saturday workshops and summer institutes.

The NYSSI was funded with $10 million from NSF- $2 million annually for five years. Now in its fifth year, the NYSSI has been able to leverage substantially more funding from other federal, State, local and private sources. The Urban Network Project, sponsored by NYSSI supports reform mainly in the State's six largest urban districts: Albany, Buffalo, New York City, Rochester, Syracuse and Yonkers. Ten research and development schools were chosen, two from most districts, to implement and study math science and technology education.[88] As with NYCUSI, the NYSSI focuses its efforts predominantly on teacher professional development.

b. SCIENCE TECHNICAL ASSISTANCE CENTERS

One of the positive initiatives during the last decade in terms of professional development has been the creation of two Science Technical Assistance Centers (STACs).[89] These centers, which provide most of the Board's professional development efforts in science education at the elementary and middle school level are coordinated through the STACs, located in Queens and Brooklyn. The centers are staffed by a small number of staff developers who conduct workshops and conferences for the educational community, including administrators, teachers, and parents. These centers serve only a small fraction of the 41,200 teachers and educators that need to be served.

Thirty of the 32 community school districts, a few high schools and other special districts utilize the STACs for science teacher training. Approximately 2,000 teachers are trained annually at the two STAC locations. The budget of the STACs has grown modestly over the years. The FY 92-93 budget increased by 9.2 percent from $813,274, to $888,348 in FY 95-96, as a result of salary increases, not program expansion. Teachers typically attend for three full days, one in the fall, one in the spring and one in the summer. Trainers at the STACs conduct model activities and lessons for teachers, and sometimes review basic course content. The program was originally designed to include follow-up to the in-class training. However, due to the high demand for training, virtually all the trainers' time is consumed by in-class training. Along with increasing demand for more training, these conditions may lead to staff burnout of the STAC personnel. The Board has failed to fill a staff vacancy since 1995.

Table 12 shows a substantial increase in the total number of teacher-days from the 3,851 days in the 1994-1995 school year to the 4,011 days in the 1995-1997 school year. There is

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[88]The New York City NYSSI schools are PS 115- Humboldt School, in District 6, and JHS 275-Thelma Hamilton School, in District 23.

[89]The assistance centers have been recently renamed Multiple Disciplinary Resource Centers. One additional STAC, located at the Board's headquarters was closed in the 1993-94 school year.

Table 12, Usage of STAC in Teacher Contact-Days by School Level and Community School District

	1994-1995			1995-96			1996-97		
	Elementary	Middle	Total	Elementary	Middle	Total	Elementary	Middle	Total
Manhattan									
CSD 1	22	9	31	14	16	31	93	8	101
CSD 2	0	3	3	50	11	63	63	25	88
CSD 3	91	30	121	37	20	57	25	13	38
CSD 4	41	65	106	57	21	78	17	36	53
CSD 5	49	5	54	32	8	43	2	20	22
CSD 6	0	58	58	0	44	44	45	33	78
Total	**203**	**170**	**373**	**190**	**120**	**316**	**245**	**135**	**380**
Bronx									
CSD 7	36	27	63	84	15	99	45	28	73
CSD 8	1	4	5	17	11	28	19	17	36
CSD 9	154	41	195	0	8	8	174	26	200
CSD 10	199	125	324	169	70	239	167	124	291
CSD 11	0	27	27	1	41	42	0	24	24
CSD 12	42	68	110	47	28	75	48	13	61
Total	**432**	**292**	**724**	**318**	**173**	**491**	**453**	**232**	**685**
Brooklyn									
CSD 13	134	18	152	88	29	117	178	0	178
CSD 14	0	23	23	0	27	27	0	20	20
CSD 15	136	38	174	124	21	145	120	33	153
CSD 16	0	0	0	0	0	0	0	0	0
CSD 17	309	13	322	161	48	209	3	0	3
CSD 18	0	24	24	2	26	28	0	21	21
CSD 19	64	12	76	62	68	130	107	26	133
CSD 20	178	16	194	125	67	192	137	52	189
CSD 21	0	0	0	0	0	0	0	0	0
CSD 22	355	30	385	138	32	170	280	28	308
CSD 23	0	10	10	0	16	16	0	0	0
CSD 32	51	28	79	0	21	21	10	41	51
Total	**1,227**	**212**	**1,439**	**700**	**355**	**1,055**	**835**	**221**	**1,056**
Queens									
CSD 24	1	26	27	0	26	26	2	10	12
CSD 25	172	66	238	138	64	202	383	53	436
CSD 26	81	35	116	70	44	114	122	34	156
CSD 27	206	75	281	222	54	276	302	66	368
CSD 28	222	65	287	254	80	334	199	66	265
CSD 29	60	30	90	87	40	127	180	53	233
CSD 30	172	79	251	178	63	241	218	63	281
Total	**914**	**376**	**1,290**	**949**	**371**	**1,320**	**1,406**	**345**	**1,751**
Staten Island									
CSD 31	0	0	0	0	4	4	0	12	12
Other									
CSD 75-89	1	24	25	0	19	19	83	44	127
TOTAL	2,777	1,074	3,851	2,157	1,042	3,205	3,022	989	4,011

Source: Board of Education.

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increased demand for specialized workshops from the individual districts. In these specialized sessions the trainers work with smaller classes.

The limited resources of the STACs also adversely affect the quality of the training. Training sessions cannot be targeted to focus groups, such as new teachers. Experienced teachers and supervisors are all trained together.[90] Since each group obviously has different needs, it would be more useful to target training to specific audiences.

Utilization of the STACs among the districts varies tremendously. Table 12 shows that some districts use the STACs as a major professional development resource while others never take advantage of the STACs to improve the skills of their educators. For example, during SY 96-97, CSD 25 in Queens utilized the STAC for 436 teacher-days in the school year, while CSDs 16 and 21 in Brooklyn never used the STAC. Also, in the SY 96-97, six school districts sent no elementary, and five sent no junior high school teachers to the STACs. Thirteen school districts recorded less than 20 elementary school teacher utilization-days in the STACs in the same school year. The corresponding number of districts for junior high school teachers was 11.

Some school districts, like District 2, have also developed their own teacher training resources and try to conduct their own professional development. Some districts neither develop their own program nor use the STACs because they may rate some other district need higher than a high quality science program. Even among the districts that send teachers to the STACs there is varied follow-up support for educators. Some teachers leave the STAC training excited and return to a non-supportive science environment. Many district science supervisors do not attend the training sessions at the STACs and therefore are limited in their ability to support newly trained teachers.[91] The result is that many teachers find it difficult to fully use their new skills because there is no formal follow-up by the STAC trainers.

The location of the STACs is also a factor in their degree of usage. The districts in the boroughs where the STACs are located utilize them significantly more than would be expected based on the number of teachers within the borough. From Figure 13 it can be seen that districts in Brooklyn and Queens, where the STAC centers are located, have a higher percentage of their teachers utilizing the STACs than districts from boroughs with no STACs. Queens, for example, utilizes 41 percent of the STAC teacher-days while Queens teachers account for only 23 percent of the City's teachers. On the other hand, while teachers from Manhattan represent 16 percent of the City's teachers they accounted for only 10 percent of the teacher-days at the STACs.

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[90]Comptroller's Office interview with STAC personnel, February 5, 1997.

[91]Comptroller's Office interview with STAC personnel, February 5, 1997.

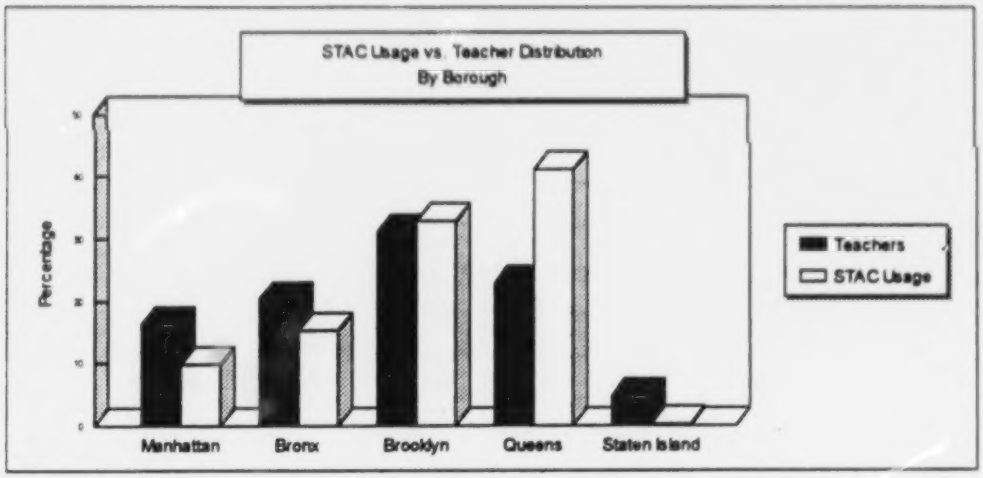

Figure 13

c. Mathematics Resource Centers

In addition to the STACs, there are also two Mathematics Resource Centers (MRCs)[92], one in Manhattan and one in the Bronx. The MRCs work to enhance teacher preparedness in mathematical concepts and pedagogical techniques through conferences, workshops and seminars. The Manhattan MRC also develops connections and educational alliances between schools and educational resources, including the NASA Center, the Workshop for Science Education, the CUNY Consortium for Effective Leadership and Urban Scholars.

One particularly interesting program, Real World Math Summer Institute (RWMSI), demonstrates the collaborative and leveraged efforts of the MRCs. Funded by the Board, RWMSI is a collaborative effort of New Visions for Public Education, City College, the Board, CUNY Consortium for Effective Leadership and several corporations and is in its seventh year. The program promotes reform in math education for middle school teachers by making math meaningful and relevant to real world experience. The three week workshops are conducted at City College, including one week of field work at corporations in the private sector. Corporations help teachers to connect the math concepts they teach in the classroom to the "real world."

For teachers without a significant math background the focus is on sharpening their understanding of the basic subject matter. With middle and high school teachers, who have had more intensive math preparation, the focus is on developing teaching techniques. Both MRCs provide training for over 5,400 participants from numerous districts and schools ranging from grades Pre-K through 12. This number has increased steadily from 5,137 participants in FY 92-93 to 5,412 in FY 96-97, see Table 13. The number of workshops, however, has remained constant at approximately 200 annually. Each MRC is staffed by a director and a part-time secretary. They train teachers and administrators who work with K-12 students. High schools utilize the MRCs more than the STACs.

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[92]These centers, as well as the STACs, have been recently renamed Multiple Disciplinary Resource Centers.

Table 13, Utilization of the Math Resource Centers

Year	Number of Workshops and Conferences	Number of Participants
1988-89	205	5,002
1989-90	205	5,072
1990-91	209	5,137
1991-92	214	5,196
1992-93	196	4,949
1993-94	210	5,209
1994-95	204	5,115
1995-96	211	5,333
1996-97	201	5,412*

Source: New York City Board of Education
*As of May 14, 1997.

Despite the fact that there is only one full time staff member at each MRC, they handle a large number of workshops. The directors of each MRC, although they both have their own projects, work together on many of the workshops that are available. The MRCs also collaborate with other organizations such as the UFT to organize and conduct workshops.

3. PRIVATE PROFESSIONAL DEVELOPMENTAL

In addition to the professional development workshops offered by the Board, there are numerous other math, science and technology programs available to the City's public school teachers, educators, students and parents. These programs are offered by New York City's science-rich institutions in the form of professional development, student programs, classroom and teaching resources, and family programs.[93] The 359 programs, detailed in a resource guide by the New York Academy of Sciences, evolved from a concern with the state of math, science and technology education in the City.

One hundred and thirty six of these programs are designed to improve teachers' scientific, teaching and research skills. The programs can be categorized as Curriculum Reform Programs, Summer Institutes, Research and Professional Internships, Conferences, Workshops and Lectures.[94]

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[93]New York is considered science-rich because it is an international center for science and technology with high-tech corporations, top research universities, pre-eminent medical centers and world class museums.

[94]New York Academy of Sciences, *New York City Math, Science and Technology Education Resources (MASTER) Guide*, Fall 1997.

Program complexity varies considerably, from one-hour workshops to research and professional internships stretching over two summers, with workshops being the popular format. Short workshops accounted for 64 percent of the professional development programs. The more intensive program formats, research and professional internships, are expensive and are available to only a small number of participants at a given time - they account for only six percent of the total number of professional development programs. For example, research and professional internships give teachers the opportunity to work as laboratory interns under the direct guidance of research scientists, for up to two years. Even though there are numerous private programs the demand, even by only the top performing teachers, far outstrip the supply. Additionally, there is still the need for intensive ongoing professional development for the average teacher. The Board and some school districts contract with CUNY and other private institutions for professional development services. However, payments from the Board have been delayed at times. For example, as of April 1998, no payment had been made for one contract with CUNY that started in February of 1997 and ended in January, 1998, even though it was funded and prepaid by NSF. These delays limit the contractors ability to hire staff and purchase essential material affecting the quality of the service provided.

A SHINING EXAMPLE: COLUMBIA UNIVERSITY'S SUMMER RESEARCH PROGRAM FOR SECONDARY SCHOOL SCIENCE TEACHERS

One excellent example of the high caliber of these private professional development programs is the Summer Research Program for Secondary School Science Teachers offered by the College of Physicians and Surgeons at Columbia University. The program is funded by several foundations and organizations. Sixty nine New York City teachers, 89 percent from the public schools, completed the program between the summer of 1990 and the summer of 1996. Teachers who have completed the program report personal and professional growth through appreciation of the scientific discovery process and a renewed ability to communicate the excitement of science to their students and fellow teachers. They also report revitalizing their science teaching by being better able to provide guidance and encouragement to their students. Preliminary program evaluations show substantial improvement in science class attendance, and in science club and Westinghouse project participation of students in the classrooms of program participants.[95] They also report "preliminary results indicate improvements in ....Regents test pass rates and scores...."[96]

The program is competitive and selects approximately 10 teachers out of 60 applicants to participate in two consecutive summers of laboratory research. Workshops are conducted that cover areas of science content, communications and specific teaching techniques. Selected science community members conduct presentations for the teachers. For example, in 1996, the

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[95]Comptroller's Office interview with Jay Dubner, Program Coordinator, Summer Research Program for Secondary School Science Teachers, Columbia University, October 28, 1997.

[96]Columbia University, Summer Research Program for Secondary School Science Teachers, 1997 Annual Report, November 1997, p. 16.

New York Hall of Science and the National Geographic Society conducted demonstrations and displayed exhibits and materials available through their organizations to teachers.

Graduates are expected to share their experiences with students and other teachers. Second-year participants provide guidance and support to new participants. The program provides each teacher with computer training, a modem and basic access to the Internet. Each teacher receives a stipend of $6,000, plus an allowance of $1,000 to enhance hands-on science activities in his/her school. To support teachers when they go back to the classroom Columbia provides resources including Internet access and E-mail networking.

Previously, the program accepted few teachers from the same school. However, this policy has changed because the program will now try to build a critical mass of teachers in the same school. This strategy is similar to that used by Teach for America with emphasis on peer support and mentorship.

E. THE CONDITION OF HIGH SCHOOL SCIENCE LABORATORIES

There is gathering momentum on a national level for the replacement of rote teaching, more commonly referred to as "chalk and talk," and memorization of scientific facts with inquiry based learning where students are encouraged to think, investigate and experience scientific principles. Inquiry-oriented investigation is of critical importance. Laboratory activities help students develop a variety of investigative, organizational, [illegible]ative, and communicative skills.[97] Since hands-on investigations and experience is fundamental, schools must have properly configured and equipped laboratories. So fundamental is the need for the laboratory experience in understanding the nature of science that the National Science Teachers Association (NSTA) recommends that laboratory experience must be included in every science program for every student. This includes hands-on experiences for preschool, elementary, middle school as well as high school students. NSTA recommends that a minimum of 60 percent of the science instruction time for elementary school students should be devoted to hands-on activities, where children are manipulating, observing, exploring, and thinking about science using concrete materials. The recommended portion of time devoted to hands-on activities for middle and high school students is 80 percent and 40 percent, respectively.

In order to determine how well-prepared New York City schools are to provide a hands-on science experience, we visited 19 high schools and surveyed their science laboratories. Four schools were chosen from each borough, with the exception of Staten Island where three schools were selected. The schools were selected to include a range of academic performance. Table 14 shows the high schools we visited. Our survey indicates that the laboratory experience of high school students falls short of the NTSA guidelines. One of the schools, South Bronx High School, had no dedicated science laboratories so students had to conduct experiments in converted classrooms.[98] These converted classrooms provide the "basic minimum" of laboratory facilities needed by students. Another school, Thomas Jefferson in Brooklyn, was excluded from our budget and laboratory utilization analysis because we were unable to obtain information critical to our study, but was included in the analysis of the physical condition of the laboratory facilities. Therefore, for the budget and laboratory utilization analysis and the facility analysis the sample size is 18.

As a result of an agreement between the Mayor and the City Council $1.4 billion, or approximately $275 million annually, will be spent on badly needed school repairs between FY 97 and FY 01. Of this amount, approximately $31 million was spent rehabilitating 24 science laboratories in 1997 and 1998. The Board plans to eventually rehabilitate 28 other laboratories. Seven of the schools we surveyed were scheduled for laboratory rehabilitation in the next two years.

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[97]National Science Teachers Association (NSTA), *A NSTA Position Statement: Laboratory Science*, http://www.nsta.org/handbook/labsci.htm, p. 1.

[98]Converted classrooms do not provide the full amenities that are available in dedicated laboratories. Depending on the configuration, some converted classrooms do not have running water, access to gas for heating, ventilation hoods or a proper power source.

Table 14. High School Laboratories Surveyed

High School	Enrollment SY 1996-97		High School	Enrollment SY 1996-97
Manhattan			**Brooklyn**	
A. Philip Randolph	1,644		Midwood	3,776
George Washington*	3,492		Samuel J. Tilden	2,411
Louis D. Brandeis	2,995		South Shore	3,051
Murray Bergtraum	3,221		Thomas Jefferson [1]*	1,346
Bronx			**Queens**	
Harry S. Truman	2,651		Bayside	2,516
Herbert H. Lehman*	3,546		Jamaica	2,627
Theodore Roosevelt*	3,938		Newtown*	4,686
South Bronx	1,049		Springfield Gardens	2,325
Staten Island				
Curtis*	2,060			
Susan E. Wagner*	2,299			
Tottenville	3,779			

* Scheduled for renovation in FY 97 - FY 98

[1] Included in facility analysis only

1. INSUFFICIENT FUNDS FOR MATERIALS AND SUPPLIES

As a result of the Math and Science Initiative, which requires that most high school students take Regents science courses, there has been a tremendous increase in the number of Regents-level science classes being offered. Unfortunately, in most schools there has not been a proportional increase in the science budget. Sixteen of the 18 schools we surveyed increased the number of science classes that require laboratory experiments between the 1993-94 and the 1996-97 school years. In nine of the schools the laboratory load at least doubled - one school, Herbert Lehman High School in the Bronx, experienced a 1,120 percent increase. The average increase in science classes and therefore laboratory load between the 1993-94 and 1996-97 school years was 90 percent. Two of the schools experienced no changes in laboratory load because they already met the standards of the Initiative.

The changes in the laboratory budget for materials and supplies did not correlate with the increases in laboratory loads. For example, although the number of sections tripled from 25 to 75 in Jamaica High School, the school received $6,110 for material and supplies in the 1996-97 school year, down from $6,401 in the 1993-94 school year, see Table 15. Seven of the 18

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Table 15, Change in OTPS Science Budget and Classes From SY 1993-94 to SY 1996-97

High School	OTPS Science Budget $ SY 1993-94	OTPS Science Budget $ SY 1996-97	% Change in Budget	Science Classes SY 1993-94	Science Classes SY 1996-97	% Change in Classes
Manhattan						
A. Philip Randolph	7,856	5,448	-30.7	47	55	17
George Washington	4,204	6,773	61.1	18	85	372
Louis D. Brandeis	5,126	6,237	21.7	30	60	100
Murry Bergtraum	5,037	5,992	19.0	27	60	122
Bronx						
Harry S. Truman	6,949	5,263	-24.3	70	61	-13
Herbert H. Lehman	6,245	7,148	14.5	5	61	1,120
Theodore Roosevelt	6,996	8,750	25.1	9	71	689
South Bronx	2,000	2,155	7.8	20	49	145
Brooklyn						
Midwood	9,152	10,908	19.2	53	86	62
Samuel J. Tilden	5,583	3,678	-34.1	46	46	0
South Shore	6,768	5,232	-22.7	38	65	71
Queens						
Bayside	4,000	4,000	0.0	38	68	79
Jamaica	6,401	6,110	-4.5	25	75	200
Newtown	8,784	8,466	-3.6	20	54	170
Springfield Gardens	2,000	4,400	120.0	15	44	193
Staten Island						
Curtis	3,833	4,379	14.2	21	33	57
Susan E. Wagner	3,640	2,143	-41.1	27	37	37
Tottenville	6,073	8,094	33.3	65	78	20

schools suffered a cut in their science budgets, five of which also experienced an increase in their laboratory load. Ten schools increased their science budgets while increasing their laboratory loads. The average increase in the budget for these nine schools was 34 percent while the corresponding increase in laboratory load was 288 percent. For example, George Washington High School increased its number of laboratory classes by 372 percent but only increased its science budget by 61 percent.

In order for high school students to develop a sophisticated understanding of scientific inquiry high school laboratories must have the proper supplies and equipment.[99] The average amount spent on supplies per laboratory classes for the 1996-97 school year ranged from $43.98 at South Bronx to $156.78 at Newtown, see Table 16. The average for all schools was $102 per laboratory class. This corresponds to a range of $0.93 per student at Wagner to $3.31 per student at A. Philip Randolph. This is an average for all schools surveyed of merely $2.02 per student on lab supplies and

[99]National Research Council, *National Science Education Standards*, 1996.

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equipment for the entire school year. The paucity of this budget is apparent when compared to a suburban district - in the Uniondale School District on Long Island, the corresponding budget is $16.79 per student.[100] This amount is also put in proper perspective when compared to the cost of replacing supplies. For the 1996-97 school year, the average school, for the 18 schools in our budget analysis, would have $5,843 to shop for the type of items listed in Table 17. This budget typically does not change when new equipment and supplies are needed by the school to offer a new science class. As expected, schools reported a much higher frequency of breakage because of the increased load on the laboratories.

Table 16, OTPS Budget on a per Student and per Science Class Basis SY 1996-97

High School	Enrollment SY 1996-97	OTPS Budget $	Number of Science Classes	Budget per Student SY 1996-97	Budget per Science Class SY 1996-97
Manhattan					
A. Philip Randolph	1,644	5,448	55	$3.31	$99.05
George Washington	3,492	6,773	85	$1.94	$79.68
Louis D. Brandeis	2,995	6,237	60	$2.08	$103.95
Murry Bergtraum	3,221	5,992	60	$1.86	$99.87
Bronx					
Harry S. Truman	2,651	5,263	61	$1.99	$86.28
Herbert H. Lehman	3,546	7,148	61	$2.02	$117.18
Theodore Roosevelt	3,938	8,750	71	$2.22	$123.24
South Bronx	1,049	2,155	49	$2.05	$43.98
Brooklyn					
Midwood	3,776	10,908	86	$2.89	$126.84
Samuel J. Tilden	2,411	3,678	46	$1.53	$79.96
South Shore	3,051	5,232	65	$1.71	$80.49
Queens					
Bayside	2,516	4,000	68	$1.59	$90.91
Jamaica	2,627	6,110	75	$2.33	$81.47
Newtown	4,686	8,466	54	$1.81	$156.78
Springfield Gardens	2,325	4,400	44	$1.89	$100.00
Staten Island					
Curtis	2,060	4,379	33	$2.13	$132.70
Susan E. Wagner	2,299	2,143	37	$0.93	$57.92
Tottenville	3,779	8,094	78	$2.14	$103.77

[100]Comptroller's Office telephone interview with Dr. Lewis, Director of Science, Uniondale School District, October 29, 1997.

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Table 17, Prices For Some Commonly Used Equipment and Frequently Broken Science Laboratory Supplies

Item	Price, $	Item	Price, $
Test Tubes	0.41	Pendulum	46
Erlenmeyer Flasks	2.06	Strobe	233
Beaker, 500ml	1.79	Air Track	469
Evaporating Dish	6.68	Ripple Tank	146
Petri Dish 100x15 mm	3.38	Tuning Fork Set	76
Volumetric Flask 100ml	14.12	Pulley Set	205
Short Stem Funnel	5.10	Multimeter	69
Safety Goggles	3.87	Oscilloscope	462
Frog	2.47	Hot Plate	129
Micro Slide Lesson Set	5.73	Eyewear Storage Unit	99
Bunsen Burner	12.50	Stream Table	519
Lenses	3.89	Charts	50
Prism	7.65	Torso Model	1,024
Rock Specimens, USA Set	44.00	Microscope	195 - 1,992
Dissection Kit	10.95	Centrifuge	495

Source: Fisher Science Education, Teacher's Resource Catalog and Reference Guide, 1997/98

Most of the schools in the survey we visited reported insufficient laboratory supplies, see Table 18. Some assistant principals for science indicated problems with the Board's purchasing process for chemicals. Some have difficulties obtaining the required chemical type or quantity. At Tottenville High School, with one of the highest sciences budget per student ($2.14), the assistant principal for science indicated that the SY 1996-97 allotment of $8,904 for supplies is "an exercise in futility with so many laboratory-based classes." Teachers at Tottenville reported being unable to conduct recommended laboratory experiments because of shortages of supplies such as chemicals, glassware, specimens and other materials. As a result of these shortages, teachers often have to choose experiments to fit the available equipment rather than on the basis of what is most interesting and useful to students. At Tilden High School, for example, students have difficulty preparing for Regents earth science and biology laboratory exams because of shortages of supplies. At Wagner, the assistant principal for science explained that the shortage of specimens ".... reduces the amount of learning the students obtain from the laboratory experience. There is no independent study."

Table 18, Major Deficiencies in Material and Supplies in Surveyed Laboratories

School	Deficiency in Specimens	Deficiency in Chemicals	Deficiency in Charts & Models	Deficiency in Glassware
Randolph	X	X	X	
Washington		X		
Brandeis	X		X	
Bergtraum				
Truman		X	X	X
Lehman				
Roosevelt	X	X	X	X
South Bronx	X	X	X	X
Tilden				X
Jefferson			X	
Midwood	X	X	X	X
South Shore				
Wagner	X	X		
Curtis	X	X		
Tottenville	X			X
Newtown				
Bayside				
Springfield			X	X
Jamaica		X		

Case Study

The close look at the A. Philip Randolph High School in Manhattan provides an insight into the failing of the system. Randolph is a top performing school in Harlem. In 1995 it was recognized by the New York State Department of Education for its excellence. In 1996, 37 percent of its graduates received Regents-endorsed diplomas - up from 29 percent in 1995. However, Randolph suffered a cut in its science budget of 31 percent between the 1994 and 1997 school years. In Fall 1997, 105 students requested, and were qualified to take AP Biology. Due to budget limitations the assistant principal had to turn away 73 qualified and motivated students because she could only offer one course with 32 students. The one AP Biology course offered was possible only because of a subsidy from "wheeling and dealing", such as driving to Long Island where the DNA Learning Center donated enzymes for experiments.

Students experienced similar frustrations with AP Physics and AP Chemistry. The assistant principal was able to offer one AP Physics course when City College allowed the high school to use its laboratory facilities. The assistant principal could not afford to buy books and laboratory

equipment necessary for the AP Physics course. Similarly, for AP Chemistry, with no money and no City College chemistry laboratory available, only one AP Chemistry course was offered.

A shortage of supplies and personnel can sometimes lead to unsafe conditions. At Truman High School, for example, there were instances where tightly scheduled laboratory sessions did not allow enough time between classes to clean up broken glass and chemical spills. This is a very serious problem and students should not be exposed to this kind of danger. This problem could be corrected by increasing the number of laboratory specialists or adding a break between experiments to allow clean-up.

Another potential safety hazard is the absence or disfunctionality of equipment to remove noxious fumes from the laboratory. Measures must be taken to ensure that all laboratories have functional ventilation hoods for this purpose. We found that in 11 of the schools surveyed, there were either no ventilation hoods or the existing hoods were inoperable. In addition, eye wash stations were absent in most of the schools. These stations serve as emergency relief in the case of an accidental splash of hazardous chemicals into the eyes or face. There have been 59 claims for the categories 'chemical/gas' and 'burned' filed with the Comptroller's Office since FY 1992. These incidents occurred in laboratories or classrooms used as laboratories. They range from claims for reimbursement of a few hundred dollars for medical expenses to a $7 million claim for damages from economic loss and medical expenses.[101]

The Board's process for procuring laboratory chemicals is inefficient and should be reviewed. Several schools mentioned that the Board's contract with chemical suppliers sometimes expires and they are left without chemicals or the chemicals on the Board's list were inadequate for what the teachers needed. In addition, there is sometimes a need for smaller amounts of a particular item which the supplier carries only in large quantities.

2. THE NEED FOR MORE LABORATORIES

The number of science laboratories at the 19 schools we surveyed ranged from none to 6, see Figure 14. As mentioned before, South Bronx High School conducted experiments in converted classrooms and had no dedicated laboratories. Tottenville High School in Staten Island was the only school in the survey with 6 science laboratories. Most of the schools, 11 in all, had either three or four dedicated science laboratories. The average number of laboratories per school surveyed was 3.5.

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[101]Many of these have not been settled, including the claim for $7 million.

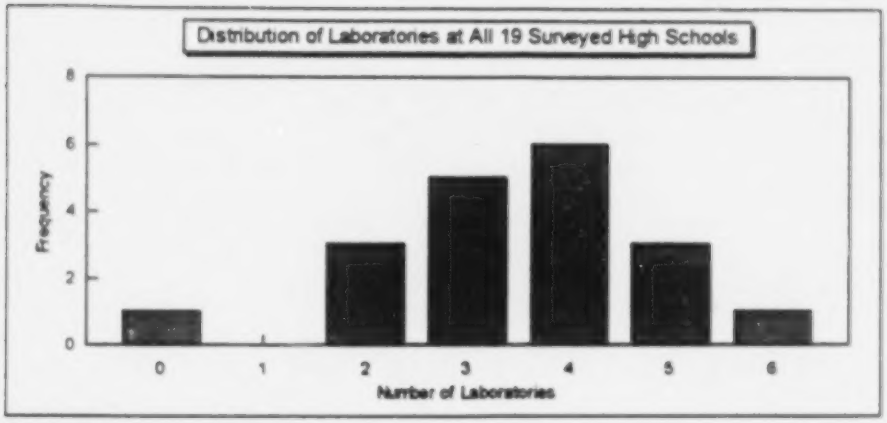

Figure 14

A closer look at the 18 schools included in our utilization analysis reveals that the ratios of students to laboratory and science classes to laboratory vary considerably from school to school, see Table 19. Five of the high schools in our sample had high, over 960:1, student to laboratory ratios.[102] These same schools also had high science class to laboratory ratios with the exception of Newtown High School, in Queens. This is because Newtown offered only 54 science classes, a low number considering it has the third highest enrollment of any school in the City. By comparison, George Washington High School with 4,042 students, offers 85 science classes. Even the 85 science courses offered by George Washington is estimated to be only 75 percent of what it should be if all students were enrolled in Regents level science classes. The corresponding estimate for Newtown is 36 percent. A high ratio greatly diminishes the quality of the laboratory experiences and results in higher breakage and wear and tear. Tottenville High School in Staten Island, with a student population of 3,762 has six science laboratories, a student to laboratory ratio of 627:1, and a science class to laboratory ratio of 13:1. On the other hand, Theodore Roosevelt High School in the Bronx, with only two science laboratories to accommodate its 4,797 students, has a student to laboratory ratio of 2,021:1 and a science class to laboratory ratio of 36:1.

Roosevelt and Murray Bergtraum high schools, with high ratios of students to laboratory were not built with enough laboratories even for normal enrollment. As a result of overcrowding, they are in dire need of additional laboratories. Three other high schools, George Washington, Midwood and Newtown, also need additional laboratories because of overcrowding. Students in science classes at Roosevelt High School conduct an average of 7 "laboratory" experiments per day. Because of insufficient facilities, many of these laboratory sessions are conducted in classrooms, depriving the students of a true laboratory experience since many experiments cannot be done in these makeshift facilities. For example, all experiments involving the use of water or gas cannot be conducted in the classrooms.

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[102]This value of 960:1 will be derived in the proceeding analysis.

Table 19. Analysis of Number and Usage of Laboratories for SY 96-97

High School	Number of Laboratories	Number of Science Classes	Number of Students per Laboratory *	Number of Science Classes per Laboratory
Manhattan				
A. Philip Randolph	4	55	411	14
George Washington	3	85	1,164	28
Louis D. Brandeis	4	60	749	15
Murray Bergtraum	2	60	1,611	30
Bronx				
Harry S. Truman	4	61	663	15
Herbert H. Lehman	5	61	709	12
Theodore Roosevelt	2	71	1,969	36
South Bronx	2	49	525	25
Brooklyn				
Midwood	3	86	1,259	29
Samuel J. Tilden	4	46	603	12
South Shore	5	65	610	13
Queens				
Bayside	4	68	629	17
Jamaica	5	75	525	15
Newtown	3	54	1,562	18
Springfield Gardens	3	44	775	15
Staten Island				
Curtis	3	33	687	11
Susan E. Wagner	4	37	575	9
Tottenville	6	78	630	13

* This is the total school enrollment divided by the number of laboratories. This ratio reflects the higher expectation that all students take Regent-level science courses.

There is a practical limit on the number of laboratory classes that can be accommodated by each laboratory. In estimating the capacity of laboratories we assume that for six of the eight periods per day the laboratories are in use, none are conducted before school, during lunch or after school. Ideally, we should be able to use the school laboratories for eight periods per day but under the current staffing levels this may not be practical given the time needed to perform set-up and clean-up activities, particularly for the more difficult experiments. The actual capacity of the laboratories will vary according to allowable class size, the duration of each laboratory session, the size and layout of the laboratory itself, the number of periods available for laboratory experiments each day, etc. The number of laboratory specialists in the school affects how quickly laboratories can be set-up and cleaned-up to allow continuous use of the laboratories with no time off between laboratory sessions.

Furthermore, these assumption make no distinctions between the types of laboratories.[103] Using the above assumptions and an average science class size of 32 we estimate the capacity of each laboratory to be 960 students per week. Table 20 shows the number of new laboratories that will be needed for schools with a high ratio of students to laboratory when the school places all students in Regents-level classes.

Table 20, Estimated Number of New Laboratories Needed Based upon One Period Laboratory Sessions

High School	Enrollment SY 1996-97 (1)	Lab Capacity (2)	Total Number of Laboratories Needed (3)	Number of Existing Laboratories (4)	Number of New Laboratories Needed (5)
			Column (1)/ Column (2)		Column (3) - Column (4)
George Washington	3,492	960	4	3	1
Murray Bergtraum	3,221	960	4	2	2
Theodore Roosevelt	3,938	960	4	2	2
Midwood	3,776	960	4	3	1
Newtown	4,686	960	5	3	2

The increased load on laboratories due to the Initiative makes scheduling laboratory experiments sometimes very difficult. To accommodate the increased load, some schools schedule laboratories before the normal first period, during lunch hour or after the last period of the normal school day. For example, students at Bayside High School come to school at 7:00 am in order to complete one laboratory experiment before the normal first period of the day. Science teachers report that this can be a disincentive for less motivated students to attend lab sessions. In most instances, students receive only one single period of laboratory experience per week for each subject. This is an insufficient allotment of time for students to grasp the concepts the labs are intended to convey. The optimal laboratory session duration is two periods. Many experiments cannot be conducted in one period even without considering the necessary setting-up and clean-up time. A. Philip Randolph High School in Manhattan, Thomas Jefferson High School in Brooklyn and Tottenville in Staten Island offer double period labs.

There are other drawbacks to having single period laboratory sessions. Many experiments require two periods, particularly experiments for higher level Regents and AP science courses. Single period laboratory sessions reduce the critical hands-on experience of students by limiting experimental time. Set-up and clean-up procedures further limit the time available for actual experimentation. It is standard practice for the public schools to offer our students science classes with only one period devoted to experimentation. Only seven of the 19 schools surveyed offer

[103]In reality, properly configured high school laboratories are highly specialized requiring specific equipment and supplies. For example a physics laboratory is ill-equipped to handle a biology experiment.

double period laboratory sessions - four of which offer double-period laboratory sessions in only some of their science classes. Many beneficial experiments - excluded from consideration because they do not fit budget and time constraints - are never to be experienced by New York City public school students.

Double period laboratory sessions are much better pedagogically than single period laboratory sessions. The State recommends, but does not mandate, double period laboratory sessions. Calculations based on NSTA recommendations of a minimum of 40 percent of the total time allocated to each science subject be spent on hands-on and laboratory related also indicated the need for double period laboratory sessions. This scheduling example would substantially reduce the capacity of the laboratories from 960 to 360 student per week. It would, however, as it should, revolutionize our students' science education. It would also make it more likely that we achieve the goals set by the Math and Science Initiative. Scheduling laboratory sessions before and after the normal school day and during the lunch period, increasing allowable class size and the number of laboratory sessions per day can restore some laboratory capacity. Table 21 shows how the City compares with the standards recommended by the NSTA. Double-period laboratory capacity can be increased to 640 students per week with some trade-offs - class sizes of 32 are allowed and four laboratory sessions are conducted each day.

Table 21, Comparison of Current Laboratory Utilization in the Surveyed high Schools and Optimal Utilization Based on NSTA Recommendations

	Current Practices in Surveyed High Schools	NSTA Recommendations
1. Number of periods dedicated to each science subject per week	6	6
2. Number of laboratory periods per week for each science subject	1	2*
3. Maximum Allowed Laboratory sessions per day**	6	3***
4. Students per class	32****	24
5. Maximum Allowed Laboratory sessions per week (Line 3 x 5)	30	15
6. Laboratory capacity (Students per day) (Line 3 x Line 4)	192	72
7. Laboratory capacity (Students per week) (Line 6 x 5)	960	360

* Based on the 40 percent of total time devoted to each science subject per week (0.4 x 6 periods = 2.4)

** Estimated

*** Based on double sessions, three double periods would be equivalent to six single periods

**** Source: NYSED, Statewide profile of the Educational System, February 1997, p. 63.

3. The Severe Shortage of Laboratory Specialists

In the schools we surveyed, the number of laboratory specialists ranged from 1 to 3 per school, while most - 13 of the 18 schools had two, see Figure 15. Figure 16 shows the comparison between the number of laboratory assistants and the calculated number, mentioned before on page 33, for selected schools. It shows that there is an insufficient number of laboratory specialists, particularly in schools with high student enrollment and a high number of science classes. Most laboratory specialists are responsible for a large number of experiments for laboratory classes. Several of the assistant principals at the surveyed schools indicated that

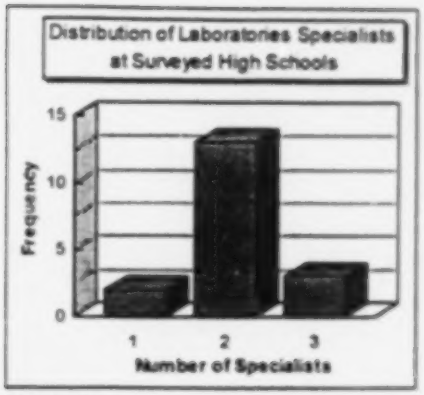

Figure 15

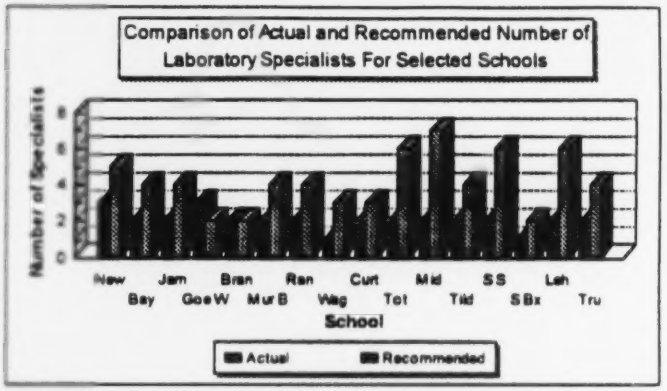

Figure 16

laboratory specialists should be responsible for a maximum of 5 experiments per day, or 25 per week.[104] The number of sections each laboratory specialist is responsible for ranges from 17 per week at Curtis High School in Staten Island to 43 per week at Midwood High School in Brooklyn. At 12 of the 18 schools laboratory specialists were responsible for more than 25 laboratory preparations per week, see Table 22. At four of the schools, laboratory specialists were responsible for 37 or more laboratory classes per week.

When the number of laboratory specialists is analyzed relative to the number of students the lack of laboratory specialists is even more clearly seen. This analysis reflects the anticipated conditions when all the students in our high schools are enrolled in Regents classes. For a school such as Newtown High School in Queens, for example, with a population of 4,797 students and three laboratory specialists, this means that there is one laboratory specialist for every 1,562 students. The ratio of laboratory specialists to students ranges from 822:1 at A. Philip Randolph High School to 2,299:1 at Tottenville High School. Sixteen of the 17 schools in our budget analysis had ratios of laboratory specialists to students of more than 960:1

In order to handle the increased load on the laboratories caused by the Initiative, schools need to double their staff of laboratory specialists - approximately one laboratory specialist per laboratory. Based on the assumptions shown in Table 23 one laboratory specialist may handle set-up and clean-up for 960 students per week for each science subject. Most schools assign their lab specialist to more than one subject because of the shortage. Also, laboratory specialists often spend time maintaining aging equipment. At Truman High School, the laboratory specialist for Biology handles 39 classes per week.[105] At Tottenville High School, with only two lab specialists, teachers choose laboratory experiments that require less preparation. Also at Tottenville, some advanced placement laboratory experiences have been reduced to video watching.

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[104]The responses ranged from 20 to 30 laboratory classes per week, and averaged 25 classes per week.

[105]In the Fall of the 1997-98 school year, Truman lost one laboratory specialist and is operating with only one laboratory specialist.

Table 22, Analysis of Number of Laboratories, Budget, Usage and Staffing for SY96-97

High School	Number of dedicated Labs	Number of Science Classes*	Number of Lab Specialists	Number of Science Classes per Lab Specialist	Ratio of Enrollment to Lab Specialists	Average Number of Lab Periods per week**
Manhattan						
A. Philip Randolph	4	55	2	28	822	2
George Washington	3	85	3	28	1,164	1
Louis D. Brandeis	4	60	2	30	1,498	1
Murray Bergtraum	2	60	2	30	1,611	1
Bronx						
Harry S. Truman	4	61	2	31	1,326	1
Herbert H. Lehman	5	61	2	31	1,773	1
Theodore Roosevelt	2	71	3	24	1,313	1
South Bronx	2***	49	1	49	1049	1
Brooklyn						
Midwood	3	86	2	43	1,888	1
Samuel J. Tilden	4	46	2	23	1,206	1
South Shore	5	65	2	33	1,526	1
Queens						
Bayside	4	68	2	22	1,258	1
Jamaica	5	75	2	38	1,314	1
Newtown	3	54	3	18	1,562	2
Springfield Gardens	3	44	2	22	1,163	1
Staten Island						
Curtis	3	33	2	17	1,030	1
Susan E. Wagner	4	37	1	37	2,299	1
Tottenville	6	78	2	39	1,890	2

* Each science class usually meets once per week for laboratory experimentation.

** Average number of laboratory periods per week for each science class.

***Classrooms used as laboratories.

4. MAJOR DEFICIENCIES IN ALL OF THE LABORATORIES

The problems of insufficient laboratory space and overtaxed laboratory specialists are further compounded by the shortage of proper equipment. All of the laboratories we surveyed had some major equipment deficiencies, see Table 23. For example, in 10 of the 19 schools we surveyed, some of the laboratory gas jets, a necessity for certain experiments, were inoperable. In several schools, sinks in many of the laboratories were unusable and many workstations had no running water. Specifically, 11 of the 19 schools with laboratories reported that they had substantial deficiencies with running water and another 10 indicated that they had clogged sinks in at least some of their laboratories. In laboratories with no gas or a limited number of Bunsen burners, teachers were either unable to conduct laboratory sessions using heat or had to improvise using hot plates or

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even alcohol lamps. These are poor substitutes, since the heat generated by these alternate sources cannot attain the necessary flame temperature which is critical for some

Table 23, Major Equipment Deficiencies Discovered in Surveyed Laboratories

School	Gas	Water	Poor Ventilation	Inoperable Power Packs	Broken Micro-scopes	Clogged Sinks	Insufficient Balances
Randolph	X	X	X		X	X	X
Washington	X	X	X				
Brandeis					X		
Bergtraum				X	X		
Truman	X		X	X	X	X	
Lehman			X				
Roosevelt		X	X	X	X	X	X
S. Bronx			X	X	X	X	X
Tilden	X	X	X	X	X		X
Jefferson			X	X	X		X
Midwood	X	X	X	X	X	X	
South Shore					X		
Wagner	X	X	X	X	X	X	X
Curtis			X	X	X	X	X
Tottenville	X	X	X	X	X	X	X
Newtown			X	X			
Bayside	X	X				X	
Springfield	X	X	X	X	X	X	X
Jamaica	X	X	X	X			

experiments. For example, experiments involving heating metals to show the characteristic color or any experiment involving boiling water. Three of the schools had at least one laboratory with no functioning power packs[106] and 13 had an insufficient number of power packs in working condition to serve the number of students enrolled in science classes. At Roosevelt High School, students sometimes have to do Earth Science, Biology and Environmental Science in the classrooms because of inadequate laboratory facilities. Both Tilden High School, in Brooklyn, and Truman High School, in the Bronx, conduct "paper laboratory" sessions because of lack of equipment and/or supplies.[107]

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[106]Power packs are electricity appliances installed in the laboratory to provide the ability to regulate alternating and direct voltages for experiments.

[107]Paper labs provide no hands-on experience for the students. For the students they are similar to classroom instruction, they involve following directions detailed on a sheet of paper - hence the term - presented by the teacher or laboratory specialist.

At Tilden there was a shortage of supplies for certain demonstrations or even to prepare for the Regents exams. In three separate schools, Theodore Roosevelt, Harry Truman and Springfield Gardens assistant principals complained of improperly placed or inaccessible gas cut-off valves.

The NSTA recommends that laboratory equipment and facilities be maintained and updated on a regular basis. The proper maintenance of the laboratories has not been a priority with the Board - some laboratories have not been updated in 30 years. The laboratories consistently lacked an adequate number of working power packs, sinks, gas and running water and hoods to remove noxious fumes. Some laboratories had no working power packs whatsoever. For example, over the years, the Board had selected and installed poor quality power packs in the schools. The Board did not adequately maintain these power packs. The schools then had to assume the recurring expense of buying batteries to use in place of the power packs, out of an already limited science budget, or choose not to conduct those experiments. Obviously, the batteries cannot fully replace power packs because of the variability and magnitude of voltage and current available from a working power pack.

These and other deficiencies reduced the number and type of experiments that could be performed. Some experiments are performed in such crowded conditions that many students "become observers rather than doers," thus limiting the educational benefit of the experiment. One assistant principal for science sums it up best: "... we are programming our kids for failure."

F. THE USE OF TECHNOLOGY IN THE PUBLIC SCHOOLS

While the educational use of technology has increased dramatically in the last five years it is still not well integrated into the public school system. Often equipment is poorly maintained, underused, or used in an inappropriate fashion. Training for teachers and other users is rare - teachers are usually self-taught. A Comptroller's audit in 1994 found that computers purchased for student use were frequently being used instead by teachers and administrators.[109]

Another report, based on a survey of selected elementary and middle schools, concluded that there was a lack of systematic wiring for technology in the schools, a lack of comprehensive professional development, lack of a City-wide plan to maintain and upgrade existing computers and insufficient funding for computers.[110] The schools surveyed expressed frustration with the poor performance of the School Construction Authority (SCA) as demonstrated by poor work, delays and high bids. Problems similar to those found in the survey were also reported by the Council of Supervisors and Administrators at a Regents Legislative Conference on September 17, 1997.[111]

The last comprehensive technology[112] survey completed by the Board in SY 1994-95 revealed that most schools used technology primarily for word processing and desktop publishing.[113] The survey, partially presented in Table 24, also found:

- three percent of all schools lacked a computer in their library;
- students in 80 percent of the schools use computers for local (e.g. CD-ROM disks) information retrieval, while only 36 percent used computers for remote information retrieval (e.g., Internet or remote databases);

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[109]New York City Comptroller's Office, *Computers in the Classroom Program: An Evaluation of the Construction and Installation of Computer Centers in Public Schools for Fiscal Year 1994*, 1995 p. ES2.

[110]Marrapodi, Maryann, Weikart, Lynne, *Not Far Enough: A Study of Technology in Selected New York City Public Schools*, Access to Learning, Inc., Summer 1997, p iii-v.

[111]CSA News, *Major Problems Exist Re: Technology/Infrastructure, CSA/NYSFSA Tells Regents at Legislative Conference*, Vol. 31, Number 2, October 31, 1997, p. 33.

[112]The term 'technology' includes computers, computer networks, computer accessories such as printers and CD-ROMs, communications equipment, audio-visual equipment, telephone lines for modems, conduits for computer network cables, electric wiring and power for computers and other communications equipment.

[113]New York City Board of Education, *Citywide Technology Survey Summary 1994-95*, 1996. This survey is the latest comprehensive technology survey available from the Board of Education.

• 24 percent of the schools still had no access to public television and 34 percent had no access to cable television;

• 30 percent of the schools had no camcorders, 54 percent had no laser disk players, 25 percent had no laser printers, 64 percent had no modems, 37 percent had no CD-ROMs;

• 69 percent of the schools still used Dot-matrix printers.

Table 24, Distribution of Technology, Excluding Computers, in New York City Public Schools SY 94-95

Type of Equipment	Percentage of Schools*				
	No Equipment	1-10 Items	11-20 Items	21-50 Items	>50 Items
Camcorder	30	70	0	0	0
Television	3	81	12	4	0
VCR	8	82	8	2	0
Laser Disk Player	54	45	0	0	0
Laser Printer	25	71	3	1	0
Dot Matrix Printer	31	48	11	9	1
Modem	64	35	1	0	0
CD-ROM	37	53	5	5	1

Source: Board of Education

* Percentages may not add up to 100 due to rounding

The Board, in mid-1997, installed 17 new computer laboratories in high schools with work stations for students equipped with 200MHz Pentium MMX processors networked by fast Ethernet connections running the Windows 95 operating system. Only one year later, the hardware and software were already a generation old.[114] However, a significant amount of our technology hardware, although still in working order, is functionally obsolete. From a more recent survey that focus on computer hardware, we found that 85 percent of the computers in schools are outdated.[115] Most of these computers are not, and cannot be used with the newer interactive multimedia resource-hungry software. Forty eight percent of the total number of computers are several generations behind the state-of-the-art. These computers include Commodore C64s, IBM PC/XT/ATs and Apple IIs. A more detailed review of the survey found great variability among districts, schools and the boroughs in the quantity and quality of computers in the schools.[116]

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[114]As of September 1998, the state-of-the-art Intel processor available was the 450 MHZ Pentium II. The state-of-the-art IBM-compatible operating system for home and educational use is the Windows 98 operating system.

[115]New York City Board of Education, Computer Survey Summary, August 20, 1997.

[116]Quality refers to how current the computers are.

School District Analysis

Most of the school districts use Apple computers - traditionally the computers of choice for educational use.[117] Three school districts used predominantly IBM-compatible computers rather than Apples. The typical district has over 1,500 computers, but few, typically 200, of these computers are current models. A detailed analysis showed that the number of students per computer in the school districts ranges from 9 student per computer in CSD 25 in Queens to 23 students per computer in CSD 11 in the Bronx, see Table 25.[118] As a borough, Staten Island, with 21 students per computer, had the fewest number of computers per student installed while Manhattan had the most with a ratio of 12:1. When outdated computers are excluded from the ranking, student to computer ratios of the CSDs change dramatically. The number of students per current computer ranges from 51 in CSD 25 in Queens to 3,387 in CSD 16 in Brooklyn. CSD 6 has no current computer models. An analysis of current computers also changes the borough rankings. The Bronx had the best ratio of students to current computers of 83:1 while Manhattan had the worst with a ratio of 126 students per current computer.

Districts need to improve their purchasing strategy for keeping up with the rapid changes in technology. While bulk purchases may be more efficient and should be encouraged by the Board, care must be taken not to fill schools with computers in one purchase and make no provision to stagger technology purchases over time. Districts should stagger technology purchases so that there is a constant incorporation of newer technology into the schools.

The PCs used in our public school system span more than four generations.[119] As computer hardware technology improves so does software technology. When software is rewritten it becomes more comprehensive and complex and requires higher capacity than the older machines can deliver. Some districts, including some with a low ratio of students to total computers and some with a high ratio, make a large one-time purchase and then never make new purchases as the technology changes. For instance, in CSD 1, in Manhattan, 92 percent of the district's computers are Apple Mac Quadras, Centris or LCs, which are one or more generations old. Therefore CSD 1 has not made any significant purchase of computers after the purchase of its Apple Mac Quandras. CSD 1 and other districts with this pattern should make more even distributed computer purchases.

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[117]The once almost exclusive use of Apple computers in education is changing. As an example of the change, Yale University in Sepetember 1997 recommended that freshmen buy IBM-compatible computers instead of Apples.

[118]The current technology plan outlined by the Board recommend student to current computer ratios of 8:1 for elementary and middle schools and 6:1 for high schools. These ratios are for current, not outdated, machines.

[119]Approximately 8 years. A generation in computer life-cycle is approximately 2 years, based on a rule of thumb known as Moore's Law, which states that performance will double every 18 months.

Table 25. Distribution of Computers, in New York City Public Schools

School District	Current Computers Pentiums or Power Macs	Outdated Computers	Total Computers	Enrollment Oct '96	Ratio of Enrollment/Total Computers	Ratio of Enrollment/ Current Computers	Percentage of Computers that are Current
Manhattan							
1	8	998	1,006	9,573	10	1197	1%
2	286	1,544	1,830	22,067	12	77	16%
3	163	1,325	1,488	15,225	10	93	11%
4	207	914	1,121	14,626	13	71	18%
5	166	916	1,082	13,933	13	84	15%
6	0	1,861	1,861	29,101	16	N/A	0%
Total	830	7,558	8,388	104,525	12	126	10%
Bronx							
7	262	831	1,093	14,627	13	56	24%
8	345	1,645	1,990	22,587	11	65	17%
9	178	1,666	1,844	30,601	17	172	10%
10	794	1,763	2,557	41,912	16	53	31%
11	182	1,012	1,194	27,721	23	152	15%
12	121	1,462	1,583	18,819	12	156	8%
Total	1,882	8,379	10,261	156,267	15	83	18%
Brooklyn							
13	72	870	942	16,148	17	224	8%
14	169	1,093	1,262	19,062	15	113	13%
15	321	1,148	1,469	21,799	15	68	22%
16	3	615	618	10,160	16	3387	0%
17	283	1,420	1,703	26,833	16	95	17%
18	171	1,136	1,307	19,203	15	112	13%
19	96	1,351	1,447	24,607	17	256	7%
20	205	1,452	1,657	27,346	17	133	12%
21	146	1,225	1,371	23,922	17	164	11%
22	326	1,573	1,899	28,858	15	89	17%
23	96	618	714	14,095	20	147	13%
32	108	729	837	15,266	18	141	13%
Total	1,996	13,230	15,226	247,299	16	124	13%
Queens							
24	274	1,589	1,863	34,726	19	127	15%
25	468	2,067	2,535	24,012	9	51	18%
26	256	758	1,014	15,890	16	62	25%
27	178	2,627	2,805	34,415	12	193	6%
28	302	936	1,238	25,660	21	85	24%
29	311	1,430	1,741	26,346	15	85	18%
30	238	1,709	1,947	27,788	14	117	12%
Total	2,027	11,116	13,143	188,837	14	93	15%
Staten Island							
31	374	1,460	1,834	38,557	21	103	20%
Total All CSDs	7,109	41,743	48,852	735,485	15	103	15%
High Schools							
BASIS*	446	2,412	2,858	45,989	16	103	16%
Bronx	418	2,206	2,624	50,458	19	121	16%
Brooklyn	506	2,327	2,833	68,312	24	135	18%
Manhattan	716	3,395	4,111	47,375	12	66	17%
Queens	400	1,869	2,269	73,562	32	184	18%
Total High Schools	2,486	12,209	14,695	285,696	19	115	17%

Source: Board of Education

* BASIS includes Staten Island and parts of Brooklyn

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High School Analysis

The majority of computers in the high schools are IBM-compatible but there are still significant numbers of Apples. High schools stagger their computer purchases better than the school districts. The high schools, however, still need to improve how well they keep up with the latest computer technology. The August 1997 survey also revealed great variability in the quantity and quality of the computers in the high schools. The Manhattan Superintendency has the lowest ratio of students to total computers and students to current computers - with ratios of 12:1 and 66:1 respectively. The Queens Superintendency had the worst ratios - 32:1 and 184:1 respectively. There are significantly fewer total computers per student in the high schools than in the school districts - high schools average 19 students per computer while school districts average 15 students per computer. High schools also have fewer current computers per student than school districts - high schools average 115 students for each current computer while school districts average 103 students per computer. High schools, however, maintain a slighter higher percentage of current computers than school districts - 17 percent of the high school computers are current while only 15 percent of the computers in the school districts are current. The Board's recent technology plan recommends that the ratio of students to computers be 8:1 in elementary and middle schools and 6:1 in high schools, however, this is contrary to current practice.

Technology serves various pedagogical purposes in schools. Students use computers for a range of activities from simple word processing applications to remote access medical research. For example, the Student Genome Project, a research collaboration with New York University and the Manhattan Center for Science and Math, introduces students to various aspects of genetic research. At Theodore Roosevelt High School in the Bronx, for example, a handicapped student has been reviewing the latest research on the cause and possible treatment of his handicap and also communicates regularly with the leading scientists in the field.

Project Smart Schools

A major initiative to install current technology in the classrooms started in September, 1997. Project Smart Schools, a collaboration with the Board, City Hall, and the private sector, has begun to provide hardware, software, professional development and technical support. The program should put four current computers and one printer in all classrooms in middle schools and all grades 6 to 8 classrooms in elementary schools. Each station will have a variety of educational software including a powerful integrated package,[120] a creative writing package and Grolier's Encyclopedia on CD-ROM. Over the four-year period FY 1998-01 $221 million in capital and expense funds has been allocated to Project Smart Schools. A total of 59,000 computers were to be installed in 14,750 classrooms in FY 1998 and FY 1999 at a capital cost of $150 million. Over $71 million in expense costs will be incurred between FY 1998 and FY 01, with $11.6 million in annual recurring costs. Table 26 shows more details.

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[120]An integrated package provides various software capabilities including word processing, spreadsheet and database management functions.

Table 26, Capital and Expense Budget for Project Smart Schools

	Budget, $ millions			
	FY 98	FY 99	FY 00-01	Total
Capital Budget				
Computers Including Software 29,500 computers @ $1,650 /year	48.70	48.70	-	97.40
Wiring 7,375 classrooms @ $3,000 / year	22.10	22.10	-	44.20
Printers 7,375 classrooms @ $525/ printer	3.90	3.90	-	7.80
Service Program 10 Facilities @ $53,000	0.30	0.30	-	0.60
Total Capital $	**75.00**	**75.00**	-	**150.00**
Expense Budget				
Staff Development	6.00	6.00	0.00	12.00
Training payment to teachers	2.60	2.50	0.00	5.10
Technical Support, Technicians	4.00	6.00	12.00	22.00
Specialists	1.00	1.50	3.00	5.50
Training for Technicians*	0.70	0.30	0.00	1.00
Computer Parts	4.80	4.80	0.00	9.60
Support for Training Facilities	0.05	0.10	0.20	0.35
Compensation to students**	0.50	1.00	2.00	3.50
Program management	3.00	3.00	6.00	12.00
Total Expense $	**22.65**	**25.20**	**23.20**	**71.05**

* Training to update skills of the existing technicians
** Students are compensated for work performed

The 1997 Summer Institute, a professional development project by the Board in collaboration with other educational organizations conducted workshops in support of Project Smart Schools for several days last summer. Technical support has been arranged as a permanent part of the program. Aside from the equipment itself, other key components affect the implementation of technology in schools, such as sufficient teacher training and computer support services, both historically in very short supply in the school system. The technical support includes a budget for staff development, technicians, software specialists and replacement of computer parts. An interesting component of the Project Smart Schools is the involvement of students in the repair of the installed computers. The Office of Instructional Technology will re-open offices in vocational technical centers around the City where the students will be trained.

Project Smart Schools will dramatically increase the use of the main telecommunications backbone for the Board - New York City Educational Network (NYCENET). NYCENET is a

free public access bulletin board linking students and teachers. It also serves as the main gateway to the Internet and other educational and administrative resources. The use of NYCENET is growing as more schools are equipped with the necessary hardware. There are approximately 20,000 registered users and over 400 schools have active accounts.

The Board's Strategic Technology Plan

The Board has outlined a comprehensive technology plan for the entire school system including not just technology for pedagogical purposes but also for more effective management.[121] The Board's plan makes recommendations on curriculum and instructional technology, assessment and accountability, professional development, administrative computing, communications and networking infrastructure, school facilities and learning environments, organization and staffing, standards, procurement and maintenance, policy and procedures, districts/Superintendency and school-level planning, and community involvement/public information and awareness. In addition to addressing current uses of technology the plan incorporates additional areas where the use of technology should be initiated, such as professional development and community involvement/public information and awareness. The plan calls for a student to current computer ratio of 8:1 in all schools, except for high schools where the recommended ratio is 6:1. The entire capital plan is estimated to cost $1.9 billion initially, and $287 million for the first 5 years of hardware maintenance. Funding for most of the project has not been secured and is not in the City Budget. The plan suggests various funding sources such as: reallocation of existing resources, community participation, donations, federal, state and private sources.

Securing these funds will present an enormous challenge to the public school system in the coming years. However, there is a bright spot. Funding for the telecommunications and networking infrastructure components of the technology plan will be financed by the Universal Service Fund (USF).[122] Initially providing discounts ranging from 20 percent to 90 percent of total cost based on the wealth and location of the school or library, the USF announced modifications to the funding mechanism. Wealth is determined by the portion of students on free or reduced lunch. The fund is now capped at $1.3 billion per year for schools and libraries, down from $2.25 billion annually initially. Nationally, approximately 30,000 applications have been submitted amounting to an estimated $2.02 billion. The Board estimates that New York City public schools will be eligible for an average discount of 80 percent and that it will leverage approximately $400 million through the USF based on local expenditures of $100 million in FY 1998. Modifications announced in June 1998 could significantly reduce the anticipated refunds.

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[121]Board of Education of the City of New York, *Strategic Technology Plan: An Integrated Community Information Technology System of Learning and Economic Development*, June, 1997.

[122]The USF was established in May, 1997 by the Federal Communications Commission to subsidize advanced telecommunications capability for rural and high-cost areas, K-12 schools and libraries. Advanced telecommunications capability will allow institutions to send and receive high quality data, voice, graphics and video communications using technology.

G. PARENTAL INVOLVEMENT

Along with teachers and administrators, parents are a key component of the educational process. Parental involvement is critical to successfully educating students. The math and science initiative will fail without active support and involvement from parents. Involved parents contribute in various ways to the education process such as volunteering, supporting students at home and galvanizing wider community support. When parents are involved, their children perform better in school, and the schools get better.[123]

Many schools have gotten worse. Several trends have contributed to worsening conditions in our public schools. These trends include: a high incidence of middle class flight to private and suburban public schools, frequent turn-over of Chancellors and strife between the school districts and the Board of Education. Perhaps most significantly, the proportion of students in the New York public school system that are poor, minority and from single-parent and welfare homes has been on the increase.

Despite these challenges, some parents want to become involved in their children's education. However, they may face other significant obstacles, such as resistance from the school, language barriers and conflicting work schedules. Parents Teachers Association (PTA) meeting are often difficult for working parents to attend. In fact, some schools don't even have a functioning PTA.[124] Parents must be educated to understand how to deal with the school system and how to support educational reform. An estimated 87 percent of children's time is spent outside the schools.[125]

The most important finding of a recent Rand Corporation study on education was that a failing school system can be turned around only if the entire community unites on its behalf.[126] While this can be accomplished in neighborhoods where students have access to telephones and computers, there are still inequities that may present obstacles to parental and community involvement. There are many neighborhoods in the City where 1 in 4 households do not have any telephones. For example, in eight community districts, six of them in the Bronx, at least 20 percent of the households have no telephone.[127]

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[123]Project Appleseed, National Campaign for Public School Improvement, *The Declaration of Interdependence*, 1995.

[124]Comptroller's Office telephone interview with Ayo Harrington, President of the United Parents Association , estimates that up to 10 percent of the schools in some districts do not have effective or functioning parents associations, April 1, 1998.

[125]Based on an average school day of 6.5 hours for 182 days per year.

[126]Rand Corporation, *Cities Mobilize To Improve Their Schools*, 1996.

[127]New York City Fire Department, *Plan for Removal of Fire Alarm Boxes*, December, 1994, Appendix B2.

The Board requires that each school in the public school system have a parent association (PA) and each community school district, high school superintendency, and citywide special education to have a presidents' council.[128] To ensure that parents are represented at the district and city-wide levels, PA presidents, or their designee, form a presidents council. In addition, the State Education Department under Commissioners Regulation 100.11 requires that all schools must develop school planning teams which require the participation of parents.

The Office of Parent Advocacy and Engagement (OPAE) is responsible for monitoring and providing support and assistance to the parent associations in all of our public schools. It has a small staff of thirteen with an annual budget of approximately $1 million, of which training and support supplies are provided. OPAE provides support in practically every area in support of parents and PAs.. Ongoing projects include; Project Read/Family Literacy, Family Math Family Science, Parent Curriculum Conference and Dial-A-Teacher. During the 1996-97 school year, OPAE responded to more than 45,000 calls - an average of 187 call per day. In order to leverage its resources OPAE has developed a video training series, which has been made available to districts and PAs.

Despite these efforts by the Board, there are significant number of schools with no functioning PA. there are varied levels of participation of parents and activity of PAs. One key factor is the support provided by the school district, particularly through the provision of a district-wide parent liaison (PL). PLs make a big difference in the existence and effectiveness of PAs. Typically, PAs perform much better in districts with PLs. Although the Chancellor's Regulation does not mandate a position of parent liaison, most districts have such an individual working full-time to facilitate parents and the PAs, while other districts only have a part-time position and others have nobody serving in that capacity. District superintendents vary in their hospitality or hostility toward PLs and the position can vanish with changes in superintendency. Currently, there are approximately 10 school districts with part-time PLs, and 5 with none. City-wide PAs were decimated in SY 1997-98 because many PA officers were hired as school aides as a result of the Chancellor's directive restricting teachers' duties to more pedagogical activities.

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[128]Chancellor's Regulation A-660, issued January 13, 1994.

H. THE IMPACT OF PEERS

It is well established that peers have tremendous influence on individual behavior. Young people tend to do what they believe their friends and peers are doing. The National Peer Helpers' Association promotes the placement of informed peer educators to help to provide accurate information, and positive peer pressure to correct misinformation and to dispel myths. Successful alternatives to incarceration of juvenile delinquents based on positive peer pressure have been applied. In fact, negative pressure has been identified as a significant barrier to African-American student performance.[129] In his book, *Beyond the Classroom*,[130] Laurence Steinberg, concludes, based on a comprehensive national study of high school students, that: 1) parents and peer pressure have the greatest influence on a student's classroom performance, 2) peer influence can grow to have tremendous importance in the later elementary school years - even more than parents and families, and 3) for many adolescents, peers are the chief determinants of their attitude toward their education and therefore their performance. The Division of High Schools already has a peer counseling network in high schools that could be extended to the other school levels and expanded to handle students' attitude toward math and science education.

In 1995, the National Action Council for Minorities in Engineering (NACME) launched a national public service advertising campaign, "Math is Power", aimed at changing students' and parents' perception of math and science. Similar programs capitalizing on entertainers and other celebrities could have a significant impact here.

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[129]Schmidt, Peter, *Study Reveals the Roots of Black Underachievement*, Education Week, June 9, 1993.

[130]Steinberg, Laurence, Op. Cit.

5

CONCLUSIONS AND RECOMMENDATIONS

BOARD OF EDUCATION COMMENTS

We provided a copy of a draft report to the Board and met with representatives from the divisions of High Schools, School Facilities, Instructional Support, Assessment and Accountability and the Office of Parent Advocacy. They provided comments to our draft, which are incorporated where appropriate. The Board essentially agreed with most of our findings and have already taken actions to implement some recommendations. We have incorporated their comments where appropriate. The full text of their comments can be found in the Appendix.

The City's public educational system is at a critical juncture. It is becoming less acceptable to have low expectations and to tolerate substandard performance from our students. Significant steps toward providing a quality education to our students are being undertaken. Many elements necessary for increased expectations and improved performance, and therefore the successful execution of the Math and Science Initiative, are already in place. This include the beginnings of an effective in-house professional development program for teachers; the existence in New York City of a world-class math, science and technology-rich community eager to contribute to the professional development of New York teachers and students; improved hiring practices at the Board of Education to attract and retain high caliber math, science and technology teachers; and increased funding to improve the physical condition of the educational infrastructure.

Even with limited resources, public school teachers have made significant contributions toward the goal of higher student performance. During the many rounds of educational budget cuts in the 1970s and again in the 1990s individual teachers have and continue to make sacrifices, e.g. using their own money to provide supplies so that children could learn. On a daily basis, many teachers start their day earlier than normal so that extra laboratory experiments can be scheduled to accommodate the increased load caused by the Initiative.[131] Also, many students who are now required to do so are taking and passing the Regents.

[131] As indicated by Dr. Galitsis, science coordinator of District 28, Mr. Brian Jetter, AP for science at Bayside High School, Catherine Henihan, UFT laboratory specialist representative.

Nevertheless, there are elements critical to successful implementation of the Initiative missing from the plan. These include effective coordination of the disparate efforts by the Board of Education itself, the Community School Districts, the individual schools, and the numerous private institutions involved. In addition, the leadership, direction and commitment from the City to provide top quality educational services and the support necessary to achieve them is essential.

Critical deficiencies lay in the preparation, hiring, retention and professional development of teachers. Teacher preparation programs must be improved. Common Branch teachers are required to undergo very little math and science training. While CUNY produces approximately half of the City's public school teachers, these teachers are more likely to perform poorly on teacher certification exams, especially when compared to SUNY and private college graduates.

In addition to poor teacher preparation, there is a major shortage of math and science teachers and laboratory specialists. An increasingly high percentage of New York City science teachers - nearly one in three - are uncertified, the highest proportion among any of the subject areas. Twenty-two years after the fiscal crisis, the Board employs half the number of lab specialists it did prior to the fiscal crisis.

Teacher shortages in math and science have always been a problem, but the advent of higher Regents expectations for students make qualified teachers in these areas doubly important. Low compensation and often poor working conditions make attracting the best teacher candidates very difficult. College graduates with quantitative, financial and computer skills are in high demand, commanding salaries from the private sector well in excess of teacher salaries. Prospective public school teachers are frustrated and discouraged by the Board's hiring practices and although improvements have been made, many more changes are still needed. After being hired, too many new teachers end up in the poorest performing schools with little or no support and are left to their own resources.

The Board's professional development programs for math and science have been described as "hit or miss." While excellent programs are available from private institutions and the Board's own MDRCs, the average public school teacher in the City does not receive the ongoing, in-depth professional development that is essential to high student outcomes and has been shown to produce a high return for the investment of educational resources. There is no coordination of this substantial resource by the Board. Some districts use it effectively - most don't. Only $1.3 million is spent on math and science professional development through the MDRCs. The Board dedicates a small staff of only eight full-time personnel to its staff development effort through the MDRC.

The major complaint of high school teachers and others is that many students enter ninth grade without the necessary math and science background. This is due, in part, to the fact that students lack a solid foundation in language arts, a critical prerequisite of a proper math and science education. Also contributing to the inadequate preparation of students is a lack of content knowledge on the parts of many elementary school teachers, causing them to shy away from in-

depth math and science instruction. Therefore, they cannot impart the solid foundation necessary for high level performance in the later grades. While, based on the experience of the professional developers at the Manhattan MDRC, middle and high school teachers generally have adequate content knowledge, they may teach by rote, and must be trained in inquiry-based math and science teaching skills.

The Board has failed to provide and maintain laboratories in adequate numbers and condition to serve the student population. Despite recent renovations of some of the laboratories, conditions are still poor. This is a result of the poor quality of the laboratory equipment and installation practices. Our survey consistently revealed laboratories with significant equipment deficiencies, such as an inadequate number of power packs or no access to gas. These and other shortcomings result in many students becoming observers and not "doers," curtailing the educational potential of experiments. In addition, proper maintenance of laboratories has not been a priority. Many laboratories do not function properly because of simple maintenance matters such as plugged drains, which made the use of sinks and running water experiments impossible. Safety in laboratories is compromised because many have no functioning hoods for noxious fume removal nor safety stations for emergency eye washes or water baths in event of a chemical splash or spill.

The Board has also failed to provide adequate supplies to allow students to experience a high level of scientific investigation. Laboratory supplies were found to be insufficient in many of the schools visited. Some assistant principals for science indicated problems with the Board's purchasing process for chemicals. Some have difficulty obtaining the required chemical type or quantity.

The goal of improving the level of education by having all high school students take three years of Regents-level math and science courses is challenging but attainable. We should not expect less or demand less from our students. To achieve higher academic performance at the end of students' school careers we must raise, not just our expectations of high school students, but those we hold for our elementary and middle school students. We must provide a higher level support for our students and teachers, consistent with the higher expectations we have of them. Based on these findings we recommend the following:

- The Board of Education should create a City-wide strategic plan for reform of math, science and technology education beyond its current New York Urban Systemic Initiative efforts. This plan should call for the active involvement of all New Yorkers, especially parents and teachers as well as civic, community, and business organizations. Furthermore, higher educational institutions, medical centers and research facilities are already heavily involved in professional development for educators and provide enrichment efforts for students. These are excellent programs that should be expanded and replicated.

- The Board should continue to improve the hiring and retention of new, qualified math and science teachers and laboratory specialists including alternative recruitment efforts such as the Board's recent recruitment of Austrian teachers. The Board should also:

  - offer scholarships and loan forgiveness programs, similar to those currently offered for bilingual and special education teachers, to math, and particularly science teachers. The cost for 1,500 teachers is estimated to be $14.5 million.

  - move toward employing only certified teachers through more aggressive recruitment practices from traditional sources; by establishing alternative recruitment programs catering to professionals in other fields who are looking for a career change; and by offering incentives to retrain paraprofessionals already employed by the Board. It should also work to raise standards of certification by supporting NCATE accreditation of CUNY teacher training colleges. It is important to ensure that qualified professionals from other fields who would like to teach for a short period in City schools are not barred from doing so by unnecessarily Byzantine regulations and requirements. This effort should complement, not conflict, with the notion of raising certification standards. At the moment, most top math and science professionals, however qualified to teach basic business or math classes, could not do so in a New York City public school.

  - endeavor to keep quality teachers. With such a high turnover rate and large disparity between the city and suburban districts, many good teachers have little incentive to seek employment in our school system or to stay here once employed. The Board has to make it attractive for teachers to work in our school system. One option is increased salaries - the Board should work with the UFT to allow pay based on demand and performance. The Board should seek the support of the Mayor to revise teacher compensation. It should seek to phase in an increase in starting salaries for all teachers, offer incentives for high-level performance, and offer a sign-on bonus for hard-to-find math and science teachers. Mentoring and other professional growth opportunities are also important strategies for improved retention. These can be achieved through better assignment of new teachers - new teachers should not by default end in the worst-performing schools. Professional development in math and science should be provided immediately after hiring.

- The Board should double its s affing of laboratory specialists to restore levels to those just prior to the fiscal crisis of 1975. It should also ensure that middle school students get the

proper support for science by assigning some of the new laboratory specialists to middle schools. Hiring 215 new laboratory specialists is estimated to cost $4.8 million annually.

- The Board should provide on-going in-depth professional development to teachers, supervisors, principals and assistant principals. It should require them to be members of their respective professional associations and encourage active participation, including time-off for conferences and other professional development programs. Substitute teachers for conference participants are estimated to cost $4.8 million annually - assuming 40 days per school. The Board should also leverage the efforts of the various private professional development programs available within New York City in math, science and technology by coordinating these efforts with its own. Focusing on professional development will improve overall performance, and raise math and reading scores for districts that perform poorly.

    - In order to make staff training more comprehensive and accessible, the Board should consolidate the Multiple Disciplinary Resource Centers (MDRCs) to one in every borough. The MDRC centers should be properly staffed with a cadre of top professionals who are experts in content and the inquiry-based method of science learning, with the ability to train others. These specialists should be in sufficient numbers to provide on-going, intensive, in-depth professional development for educators. The centers should promote interaction among math, science and technology teachers to foster active collaboration between the disciplines. An enhanced math, science and technology professional development program will also help to attract and keep good teachers. This is estimated to cost approximately $4.4 million.

- The Board must bring all the laboratories up to working order by correcting deficiencies.

    - Add new laboratories to schools that have a severe shortage of laboratory facilities. Estimated cost: $73 million.

    - There is much support for the institution of double-period laboratory sessions but because of the number of variables involved, including overcrowding and new standards, we recommend that the Board conduct a detailed analysis of the implementation of double-period laboratory sessions in all high schools. Assuming that half of the laboratory specialists (including new hires) and half of the high school science teachers are paid overtime, it is estimated that the personnel cost of double sessions would be approximately $12.3 million per year. This may also help to attract more science teachers to our school system.

    - Increase the annual budget for laboratory supplies to allow replacement of broken equipment and supplies. If we were to allocate $4 for elementary, $7 for junior high, and $10 for high school students the cost is approximately $5.3 million.

- Improve the maintenance of laboratories in order to keep them functioning properly between rehabilitation intervals. Simple problems such as clogged drains and inoperable ventilation hoods should not be allowed to hinder our children's education. These repairs can be very easily handled by the building custodial staff.

- The Board must improve its purchasing process for chemicals and supplies. The current program leaves schools without supplies and/or forces them to buy in much larger quantities than necessary. The cost of reorganizing its purchasing practices is minimal.

- The School Construction Authority needs to improve the quality of its construction and rehabilitation of laboratories. Attention must be given to the appropriate placement of gas cut-off valves and other critical equipment. Laboratory hardware such as power packs and plumbing must be of better quality. Additional features such as ventilation hoods and eye washes must be incorporated into new and rehabilitated laboratories. The cost of ventilation hoods ranges from $2,500 to $8,000. Eye wash stations cost up to $300. These items should not add appreciably to the cost of a renovation.

- The Board should ensure that all students have reasonable access to current technology.

  - The Board should work toward meeting the standards recommended in its technology plan of six students per computer in high schools and eight students per computer in elementary and middle schools. Every library and every classroom should be connected to the Internet. The Board's strategic technology plan estimates the initial cost to be $1.9 billion, and maintenance costs over a 5-year period to be $287 million.

  - The Board should study the best ways to provide current computers and other technology. The Texas Board of Education is currently considering leasing nearly 4 million laptops for its students as an alternative to purchasing books. The Board should evaluate:

    - staggered purchases
    - lease versus buy options

- The Board should ensure that all schools have active PAs/PTAs. All school districts should have a dedicated full-time position of parent liaison to ensure the level of support at the district level.

- The Board should expand the current high school peer counseling network to incorporate elementary and middle schools and add as a goal improving students' attitudes towards math and science through positive peer influence. It should also develop a City-wide public service advertising campaign aimed at changing students' and parents' perception of math and science.

6

APPENDIX

BOARD OF EDUCATION'S RESPONSE

BOARD OF EDUCATION OF THE CITY OF NEW YORK
RUDOLPH F. CREW, Ed. D., Chancellor
OFFICE OF THE CHANCELLOR
110 Livingston Street - Brooklyn, NY 11201

August 5, 1998

Jeanne Millman, Director
Office of Policy Management
New York City Comptroller's Office
1 Centre Street - Room 510
New York, NY 10007

Re: The Math and Science Initiative in New York City Public Schools

Dear Ms. Millman:

Enclosed is the Board of Education's (BOE) official response to the above study, indicating our agreement with the general thrust of the study.

In September 1997, the Board adopted a number of major initiatives which will generate significant improvement in student performance in mathematics, science and related curricular areas. Specifically, the Board has adopted the *New Standards™ Performance Standards* and calibrated the Mathematics performance standards to reflect our local instructional needs. The Board will tailor the Science performance standards for system-wide implementation during the 1998-99 school year.

In addition, the school system will bring its mathematics assessment program in line with that of the State, which has adopted a change in design to include performance assessment. A Request for Proposal has been developed and disseminated to identify a publisher to design a tool for City use.

The Board is pleased that the Comptroller's Office acknowledges our efforts to improve the quality of education, and that many of the elements for increased expectations and improved student performance are in place.

Sincerely,

Judith A. Rizzo
Deputy Chancellor for Instruction

JAR:msk
enclosure
c: Rudolph F. Crew
Lou Benevento
Robert Tobias
Donna Lynne
Lewis H. Spence
Michael Carter
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Eileen Reilly
Lynne Savage
Howard Tames
Len L. Davis
Sandy Goodman

Recommendation 1:

The Board of Education should create a City-wide strategic plan for math and science educational reform. This plan should call for the active involvement of all New Yorkers, especially parents and teachers as well as civic, community and business organizations. Furthermore, higher educational institutions, medical centers and research facilities are already heavily involved in professional development for educators and provide enrichment for students. These are excellent programs that should be expanded and replicated.

Response to Recommendation 1:

The Board of Education has a City-wide strategic plan for mathematics and science educational reform. It is called the New York City Urban Systemic Initiative (NYC USI). The NYC USI is a New York City Board of Education and City University of New York collaborative program, funded by the National Science Foundation (NSF). It is in its fourth year of a five year $15 million dollars grant. These are catalytic funds. NYC USI's mission is to reform mathematics, science and technology education reform, K-16. New York City is one of twenty Urban Systemic Initiative projects across the country. Chancellor Crew has established NYC USI as the organizing principle and driving force for the reform of mathematics, science and technology education, K-12. He charged NYC USI with the rollout of the mathematics and science standards. That is, calibrating them for New York City, making the field aware of them, and designing and implementing professional development based upon them.

NYC USI was refocused and restructured during Spring 1997. Its organization includes the Chancellor of the Board of Education (BOE) and the Chancellor of the City University of New York (CUNY), as Principal Investigators; the Chief Executive for School Programs and Support Services (BOE) and the University Dean for Academic Affairs (CUNY), as Co-Principal Investigators; the forty (40) Districts; CUNY Deans of Education; Director; Deputy Director; five (5) Borough Coordinators; and a Research Associate. Each of the 40 districts has a Urban Systemic Initiative Liaison.

The NSF's model for systemic reform contains six drivers. The first four are "process drivers" that focus on sustainable success in changing the system.

Driver 1: Rigorous, standards-based instruction for all students, and the curriculum, professional development, and assessment systems to support that instruction.

Driver 2: A unified set of policies that facilitate and enable Driver 1.

Driver 3: A unified application of all resources to facilitate and enable Driver 1.

Driver 4: Mobilization of the full community of stakeholders on behalf of facilitating and enabling Driver 1.

The last two are "outcome drivers" that underscore the student-centeredness of entire systemic reform effort.

Driver 5: Increased student attainment in science, mathematics, and technology.

Driver 6: Reduction in attainment differences between those traditionally undeserved and their peers.

The following are the goals of the New York City Urban Systemic Initiative's Restructured and Refocused Strategic Operational Plan (July 1997), year four of the program (1997-98).

Goal I: To improve organizational leadership in the New York City Urban Systemic Initiative so it can effectively lead a full system rollout of both Mathematics and Science Standards.

Goal II: To develop among professionals and partners, superintendents, principals, teachers and parents, an understanding of the Mathematics and Science Standards and the role of nationally validated curriculum in moving towards a more mathematically and scientifically literate and competent student body, public school system, city and work force.

Goal III: To develop and more effectively coordinate mathematics, science and technology professional development activities so that Goals II and IV are achieved.

Goal IV: To improve student achievement in mathematics, science and technology at the school, district and citywide levels as measured by the new state and city assessments.

NYC USI has achieved its year four goals. Under a revitalized leadership team, significant efforts were made to move New York City to a standards-based instructional system. In line with its mathematics, science and technology reform agenda, New Standards Performance Standards for Mathematics were calibrated and the process of citywide implementation, with appropriate professional development, has begun. Conceptual planning for the Fall 1998 calibration of the New Standards Performance Standards for Science has also been undertaken. The introduction and in-depth use of standards-based curricula continued at a rapid pace and was supported by extensive professional development. Achievement in high level mathematics and science is improving for students K-12. The effective involvement of stakeholders as resources and as advocates for New York City's mathematics, science and technology reform agenda has been effectively broadened and strengthened, especially through the re-establishment of the NYC USI Advisory Council.

The following are the goals of the 1998-99 NYC USI Strategic Operational Plan (Year 5 of the program):

Goal I: To expand and enhance the instructional capacity of schools to meet high standards in mathematics and science education.

Goal II: To expand and enhance the involvement of the community of stakeholders in order to facilitate system-wide mathematics, science and

Goal III: To improve student achievement in mathematics, science and technology, as measured by the new state and city standards-based assessments.

Goal IV: To promote the use of technology within schools and throughout the school system to assist students in meeting and exceeding New Performance Standards in Mathematics and Science.

BOARD OF EDUCATION OF THE CITY OF NEW YORK
RUDOLPH F. CREW Ed. D., *Chancellor*
OFFICE OF THE CHANCELLOR
110 LIVINGSTON STREET - BROOKLYN, N.Y. 11201

MEMORANDUM

July 1, 1998

To: Michael King

From: Howard S. Tames

Subject: Response to Recommendation 1B from Comptroller's Draft Report on Study of Math and Science Initiative

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The following answers are directed to the recommendations subsumed in Item 1B of the above draft report. I tried to use the framework provided in your June memorandum, but it was not uniformly applicable to the issues raised.

1- Employ only certified teachers through more aggressive recruitment practices from traditional sources

A: Agree. Recommendation is being implemented.

Working with deans of education at local colleges to encourage expansion of teacher preparatory programs in the areas of math and science;

Sending information about the NYC public schools to out-of-town colleges to attract certified math/science teachers;

Participating in career fairs and consortia, etc. to discuss employment opportunities for math and science teachers;

Selecting a local college to collaborate with a hard-to-staff district and building a relationship between the two, in terms of the student teaching experience and eventual employment of graduates, familiar with the district, in one of the district schools;

Utilizing current math and science teachers as recruiters to visit campuses and meet with math and science non-education majors;

2- Establishing alternative recruitment programs catering to professionals in other fields (looking for career change)

A: Agree. Recommendation is being implemented.

Working with Teach For America in recruitment and placement of (non-education) math and science majors in hard-to-staff districts;

* DIVISION OF HUMAN RESOURCES * 65 COURT STREET * BROOKLYN, NY 11201 *
* BUREAU OF RECRUITMENT PROGRAMS * (718) 935-2449 * FAX (718) 935-3532 *

Working with the Peace Corps to recruit and place (non-education) math and science majors in hard-to-staff districts;

Also, see #5.

3- Offer incentives to retrain paraprofessionals already employed by the BOE

Note: Paraprofessionals have a Career Training Program (CTP) that provides tuition assistance to them for college credits. Most paras are high school graduates with little or no college credit. CTP will pay tuition for up to six credits per semester to encourage paras to further their education. Additional incentive is provided in the form of pay increments based upon the number of credits completed. Currently, there is no stipulation prescribing that credits/courses be taken in math or science, nor is there any extra incentive for doing so.

4- Raise certification standards by supporting NCATE accreditation of NYS teacher training institutions

C: Disagree. Not applicable.

NCATE accreditation does not fall under the jurisdiction of the BOE. The quality of New York State teacher preparatory programs is regulated by the NYS Education Department

5- Ensure that byzantine regulations and requirements do not bar qualified professionals from other fields from teaching in the NYC public schools (without compromising standards)

A: Agree. See explanation.

There is a hierarchy of credentials that ranges from fully State certified and City licensed personnel to uncertified teachers. Depending on the need for teachers in a given area, BOE can hire staff who are not certified. Because the need for math and science teachers far exceeds the supply of certified teachers in these subjects, the BOE--with New York State's oversight--employs uncertified teachers to fill the shortages. As a condition of employment, uncertified teachers are required to follow a written plan, leading to certification.

This mechanism promotes the entry and upgrading of teaching staff in these two disciplines and provides an avenue for individuals who did not major in education, but have sufficient background in math or science to find gainful employment with the Board. Such personnel may be recent college graduates, career changers or retirees.

BOARD OF EDUCATION OF THE CITY OF NEW YORK
RUDOLPH F. CREW, Ed. D., Chancellor

OFFICE OF THE CHANCELLOR
110 Livingston Street - Brooklyn, NY 11201

MEMORANDUM
June 16, 1998

TO: Michael King

FROM: Elspeth Taylor
Chief Information Officer
Division of Management Information Services

SUBJECT: New York City Comptroller's Office of Policy Management's Draft Report on its Study of *The Math and Science Initiative in New York City Public Schools* (May 13, 1998)

Following are my comments on Recommendations 4a and 4b on the above mentioned report. If you need additional information, please feel free to call Susan Levine at Ext. 4746.

Recommendation 4a: The Board should work toward meeting the standards recommended in its technology plan of six students per computer in the high schools and eight students per computer in elementary and middle schools. Every library and every classroom should be connected to the Internet. The Board's strategic technology plan estimates the initial cost to be $1.9 billion, and maintenance costs over a 5-year period to be $287 million.

The Board's Strategic Technology Plan outlines the goals for the next five years for bringing technology into the schools. It guides our program implementation and use of funds towards the goal of infusing technology into the daily life of the classroom.

Project Smart Schools (PSS) and coordination of the Resolution A funding are two programs that have made significant progress towards attaining the desired student to computer ratios, and bringing the computers into the classroom environment where true integration can occur. PSS is bringing 4 computers and a printer, with a suite of tool software into every grade 6-8 classroom. Resolution A funds provide the same configuration to other grades and upgrade computer laboratories in selected schools.

Project Connect will bring the Internet into a minimum of 5-10 classrooms in every school as well as in the library and an administrative site over the next year.

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Recommendation 4b: The Board should study the best ways to provide current computers and other technology. The Texas Board of Education is currently considering leasing nearly 4 million laptops instead for all its students as an alternative to purchasing books. The Board should evaluate: staggered purchases and lease versus buy options.

The Board, as well as individual community school districts, is continually studying various options to provide the schools with state of the art technology and quality services in the most cost efficient manner. Where applicable and appropriate, leasing options are employed.

BOARD OF EDUCATION OF THE CITY OF NEW YORK
RUDOLPH F. CREW, Ed. D., Chancellor
OFFICE OF THE CHANCELLOR
110 Livingston Street - Brooklyn, NY 11201

July 6, 1998

MEMORANDUM

To: Michael King
Office of Auditor General

From: David Bass
Executive Assistant

Subject: New York City Comptroller's Draft Report on The Math and Science Initiative in New York City Public Schools (May 13, 1998)

Recommendation 1c in the above-referenced draft report states that salary increases for math and science teachers should be based on "demand and performance." Such a proposal is one that the Board cannot implement unilaterally. It must be bargained with the UFT. The current collective bargaining agreement with the UFT does provide in Article 7O (Shortage License Areas) that teachers in shortage license areas may teach up to five additional periods per week on a regularly scheduled basis. Teachers who do so earn an additional $3,600 per term, or $7,200 per school year. Clearly this provision is not the same as what is being proposed, although it was a mechanism developed to maintain quality instruction and to retain teachers in license areas in short supply.

The City's Comptroller's recommendation that salary increases for math and science teachers should be based on the large demand for well-qualified teachers in these license areas as compared to their short supply, as well as upon the performance of teachers in these license areas should be dealt with in the upcoming round of bargaining with the UFT. The Comptroller's recommendation will be given appropriate consideration by the Chancellor and the Board as they prepare management's demands for the next round of bargaining with the UFT, which by the terms of Article 35 of the current collective bargaining agreement can commence no sooner than May 15, 2000.

DB:fd
c: Dale C. Kutzbach

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BOARD OF EDUCATION OF THE CITY OF NEW YORK
RUDOLPH F. CREW, Ed. D., *Chancellor*
OFFICE OF FINANCIAL OPERATIONS
65 COURT STREET, BROOKLYN, New York 11201

MEMORANDUM

DATE: June 18, 1998

TO: Michael King

FROM: Louis Benevento

SUBJECT: **NYC Comptroller's Office Draft Report on Math and Science Initiative**

In response to recommendation 3e of the subject audit report, the Office of Purchasing Management will take the following actions regarding the purchasing of chemicals and related supplies:

1. Review the purchasing volume and need for chemicals currently being purchased.

2. Coordinate the formation of a committee comprised of science teachers and lab specialists to prepare a list of needed chemicals and related supplies that are not currently under contract.

3. Add smaller sizes for widely used chemicals (e.g., 16 oz. or 32 oz. size as well as 64 and 128 oz. sizes).

4. Add additional grades to the Board's list of available chemicals to provide teachers with a wider choice to better satisfy their needs (e.g., hydrogen peroxide 3% - reagent grade, hydrogen peroxide 3% - science grade, etc.).

In addition, OPM is utilizing its Bid Tracking System to regularly check the status of Board contracts for chemicals and related supplies to facilitate the planning and preparation of new contracts 6 months in advance of the expiration of old contracts.

Implementation of actions 1 through 4 will start at the beginning of the new school year and will be targeted for completion by the end of Fiscal Year 1999.

If you have any questions or need further information before then, please call me.

Thank you.

LB:dkg

c: Vincent Giordano
E. A. Palmer
Olga Nieves

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BOARD OF EDUCATION OF THE CITY OF NEW YORK
RUDOLPH F. CREW, Ed. D., *Chancellor*
OFFICE OF THE CHANCELLOR
110 Livingston Street - Brooklyn, NY 11201

MEMORANDUM

July 9, 1998

TO: MICHAEL KING

FROM: Michael Carter

RE: Controller's Audit

Upon review of the audit report, I have provided a response to the following items:

The Board should ensure that all schools have active PTAs; meetings should be held so that they are convenient for parents to attend and childcare should be provided.

- The Board should develop programs to actively involve parents in their children's education. The checklist from the Center on Families, Communities, Schools and Children's Learning is a good resource,
- helping families to establish home environments to support learning,
- using effective forms of school-to-home and home-to-school communications,
- recruiting and organizing parents to help and support the schools,
- providing information to families about how to help students at home with homework and other curricular-related activities, decisions and planning,
- including parents in school decisions and developing parent leaders and representatives,

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- identifying and integrating resources and services from the community to strengthen school programs, family practices and student learning and development,

In response, please be aware that:

The Board of Education through the Office of Parent Advocacy and Engagement (OPAE) provides extensive monitoring, technical assistance and training for parent associations. There is the Blue Book, which is the Board of Education's policy regarding parent associations, Chancellor's Regulation A-660, which is the regulation which speaks directly to parent association operations and sections of other regulations and Standard Operating Procedures which provides guidelines for parent associations.

The Office of Parent Advocacy and Engagement has developed a video tape training series which has been made available to districts and parent associations to provide assistance. OPAE also works closely with districts' parent liaisons to help fulfill their role as a resource person to parent associations.

There have been a variety of projects and programs to help enhance parent participation in their children's education.

- Project Read/Family Literacy
- Family Math/Family Science
- Standards Presentations
- Parent Curriculum Conferences
- District Parent Training Teams
- Computerized Telephone Networks between school and home to provide pertinent information
- A broad range of workshops, seminars and information provided by districts and central headquarters' offices (Early Childhood, Bilingual Education, SETRC, Funded Programs, etc.)
- Dial-A-Teacher conducted by the UFT
- There are a variety of community based/agency programs provided in schools to assist families (i.e., Beacon schools, health clinics, etc.)

All schools have been required by the State Education Department under Commissioners Regulation 100.11 to develop school planning teams. These school planning teams require participation from administration, faculty and parents. Under the new governance legislation, school planning teams have been strengthened. During school year 1997-98, Deputy Chancellor Spence conducted an extensive outreach to all the districts to develop a plan for the improvement and implementation of school leadership teams.

The use of volunteers in the school setting is not a new approach. Many schools utilize parents as volunteers to assist in a variety of ways. The New York City School Volunteer Program is a highly respected resource which provides screening, training and monitoring for volunteers. Individuals learn how to tutor and read with youngsters during the school day.

BOARD OF EDUCATION OF THE CITY OF NEW YORK
RUDOLPH F. CREW, Ed.D., *Chancellor*

OFFICE OF THE CHANCELLOR
110 LIVINGSTON STREET · BROOKLYN NY 11201

Reference No. 1998 - 400

July 6, 1998

MEMORANDUM

TO: Michael King
Project Leader, Office of the Auditor General

FROM: Patricia Zedalis

SUBJECT: Division of School Facilities' Response to the New York City Comptroller's Office of Policy Management's Draft Report on its Study of The Math and Science Initiative in New York City Public Schools (May 13, 1998)

Attached, per your request, is the Division of School Facilities' response to recommendations 3a, 3d, and 3f of the subject draft report by the New York City Comptroller's Office.

Also, concerning the draft report's findings, please note that on page 61, second paragraph, the figures on spending and science laboratories should be changed. In FY 1997, $59.8 million from the Mayor's and City Council's allocation was spent rehabilitating 39 science laboratories. For FY 1998, the Board scheduled another 15 laboratories for rehabilitation at $28.3 million.

PZ:RM:pl

Attachment

c: Rose Diamond
Michael Burke
Mark David
Cheryl Francis
Joseph Nappi
James Lonergan
Robert Meeker
File

DIVISION OF SCHOOL FACILITIES • 28-11 QUEENS PLAZA NORTH • LONG ISLAND CITY, NEW YORK 11101

RESPONSE TO RECOMMENDATION ONE IN THE COMPTROLLER'S REPORT

"THE MATH AND SCIENCE INITIATIVE IN NEW YORK CITY PUBLIC SCHOOLS"

May 13, 1998

Prepared by: Robert J. Kane, Ed. D.
Deputy Director
New York City
Urban Systemic Initiative
May 26, 1998

Response to Draft of
The Math and Science Initiative in New York City Public Schools
prepared by the office of Alan Hevesi, Comptroller of the City of New York

The Math and Science Initiative in New York City Public Schools is a four part document consisting of an introduction, a background, and descriptions of challenges facing and conditions inhibiting the initiative. The first two sections, in the main, are factual and present a balanced picture of the state of science and mathematics education in the City through approximately June '97. Beginning September '97 (approximately) a number of major initiatives were adopted citywide to generate significant improvement in student performance in mathematics, science and related curriculum areas.

The "Challenges Faced by the New Initiative" section (page 10) of the report states " The decision to implement the City-wide initiative for public high school students was a step in the right direction, but *a lot more work must be done to attain the standard of education the Chancellor had set out to achieve*.. Several factors make this undertaking particularly challenging. " Beginning approximately September '97 a great deal of work has been done to address both the effect of these challenges and the conditions that inhibit the initiative. Below are some examples of the work currently in progress:

Mathematics

- The adoption and calibration of Mathematics Standards

Using the model established through the system's adoption and customization of the New Standards Performance Standards for Language Arts, Mathematics Standards have been tailored for system-wide adoption reflecting local instructional needs.

- Mathematics Standards Professional Development

An ongoing program of professional development for Community School District and High School Superintendency leadership teams in classroom based adoption of the above mentioned Mathematics standards will be offered during the 1998-'99 school year.

- Improved Mathematics Assessment

The school system will bring its mathematics assessment program in line with that of the State, which has adopted a change in design to include performance assessment. A Request for Proposal has been developed and disseminated to identify a publisher to design a tool for city use.

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Science

• The adoption and customization of Science Standards

Using the model established through the system's adoption and customization of the New Standards Performance Standards for Language Arts, science standards will be tailored for system-wide adoption reflecting local instructional needs during the '98 - '99 school year.

• Science Standards Professional Development

An ongoing program of professional development for Community School District and High School Superintendency leadership teams in classroom based adoption of the above mentioned Science standards will be offered after customization is completed.

Technology

• Project SMART Schools - Computers for Middle School Classrooms

Project SMART Schools has begun a process in which the majority of the system's middle school classrooms will be equipped with up to date computers by Summer '99. Significant professional development has been and will continue to be offered to teachers utilizing these computers. The project has taken considerable steps to increase the capacity of Community School Districts to integrate technology into the instructional program.

• Project CONNECT - Internet Connectivity for Schools

Project CONNECT will provide a significant amount of Internet connectivity to all of the system's schools by June 1999. Professional development in the use of the Internet as an instructional resource will be provided to a great number of teachers who will use this connectivity.

• Resolution A - Increased Technology and Professional Development for Schools

Under the Resolution A program a great many schools will receive additional computers. An extensive professional development program in the classroom use of computers will be provided under this program during the '98 - '99 school year.

• TLCS (Technology for Literacy, Content and Standards) - Professional Development for Middle School Teachers

Beginning in Summer 1997 several hundred middle school teachers participated in the TLCS (Technology for Literacy, Content and Standards) program. This professional development institute addressed approaches to improve mathematics and science instruction, foster the acquisition of literacy skills, and promote the adoption of performance standards through the use of computers and appropriate software in the classroom.

• Reinventing Education Program - Technology Supported LA Assessment

During the 1997 - '98 school year the IBM Corporation awarded the school system a Reinventing Education 2 Grant. Under this program three Community School Districts were selected to pilot the use of software that allows teachers to assess the writing performance standards for grade 8

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students. These districts are receiving computers, software and professional development.

English and Reading

The report states "In order to excel in almost any subject area, a student must have a good command of the English Language." Under programs such as Project Read, the system has taken a number of important initiatives to improve student literacy skills. The school system, in collaboration with educational publishers, has developed and adopted the ECLAS and the E-PAL assessment tools which allow teachers to monitor the developmental level of reading and writing in the early elementary grades. These initiatives will impact student mathematics and science achievement through improved literacy.

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RESPONSE DATE: June 1998

AUDIT TITLE: The Math and Science Initiative in NYC Public Schools

AUDITING AGENCY: NYC Comptroller's Office

DIVISION: School Facilities

DRAFT REPORT DATE: May 13, 1998

AUDIT NUMBER: N.A.

B. RECOMMENDATION WITH WHICH THE AGENCY AGREES BUT IS UNABLE TO IMPLEMENT

3a. Add new laboratories to schools that have a severe shortage of laboratory facilities which is estimated at $73 million by the Comptroller's Office.

REASONS FOR INABILITY TO IMPLEMENT

3a. Using a total of $88.1 million from the Mayor and the City Council in Fiscal Years 1997 and 1998, the BOE began a program of rehabilitating science laboratories in 54 high schools under the construction management of the School Construction Authority.

Unfortunately, due to the need to address critical building rehabilitations, additional science laboratory upgrades as well as the addition of new laboratories are not proposed for FY 1999. Also, adding new laboratories in existing severly overcrowded high schools would be a very difficult proposition. This would result in the loss of other classroom space.

WHAT IS NEEDED TO ALLOW FOR IMPLEMENTATION

3a. The Board is currently developing its proposed five-year plan which encompasses FY 2000-2004. This plan will include a funding request to upgrade all science labs in high schools by the year 2005.

RESPONSIBILITY CENTER

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Signature: Rose Diamond

Print Name: Rose Diamond

4/19/98
Date

Print Title: Sr. Director For Capital Planning & Development

RESPONSE DATE: June 1998

AUDIT TITLE: The Math and Science Initiative in NYC Public Schools

AUDITING AGENCY: NYC Comptroller's Office

DIVISION: School Facilities

DRAFT REPORT DATE: May 13, 1998

AUDIT NUMBER: N.A.

A. RECOMMENDATION WITH WHICH THE AGENCY AGREES AND INTENDS TO IMPLEMENT

3d. Improve the maintenance of laboratories in order to keep them functioning properly between rehabilitation intervals. Simple problems such as clogged drains and inoperable ventilation hoods should not be allowed to hinder our children's education. These repairs can be very easily handled by the building custodial staff.

RESPONSE TO RECOMMENDATION - IMPLEMENTATION PLAN

3d. The BOE began an extensive program in 1997 to rehabilitate school science laboratories. The ongoing maintenance of these laboratories may come under various jurisdictions depending on the nature of the needed repairs. For example, clogged drains would usually be the responsibility of the custodian to fix. Inoperable ventilation hoods and other room repairs may be handled either by the DSF's skilled trades or through outside contract work. In these instances, the custodian should complete a work request (P.O. 18) and send it to the district plant manager for processing. Other laboratory issues concerning equipment maintenance would fall under the jurisdiction of the High School Division.

DSF will issue a circular to all custodians reminding them of their responsibilities concerning the maintenance of school laboratories and that they are to submit work requests for any outstanding laboratory repairs. The Area Offices will review the repair requests to determine whether they can be handled by the in-house skilled trades, given to a private contractor, or referred to the SCA for a capital project; e.g., as part of a future laboratory rehabilitation.

IMPLEMENTATION DATE

August 1998

RESPONSIBILITY CENTER

Signature: _____

Print Name: Michael Burke

Date

Print Title: Acting Director of Building Services

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RESPONSE DATE: June 1998

AUDIT TITLE: The Math and Science Initiative in NYC Public Schools

AUDITING AGENCY: NYC Comptroller's Office

DIVISION: School Facilities

DRAFT REPORT DATE: May 13, 1998

AUDIT NUMBER: N.A.

A. RECOMMENDATION WITH WHICH THE AGENCY AGREES AND INTENDS TO IMPLEMENT

3f. School Construction Authority needs to improve the quality of its construction and rehabilitation of laboratories. Attention must be given to the appropriate placement of gas cut-off and valves and other critical equipment. Laboratory hardware such as power packs and plumbing must be of better quality. Additional features such as ventilation hoods and eye washes must be incorporated into new and rehabilitated laboratories. The cost of ventilation hoods range from $2,500 to $8,000. Eye wash stations costs up to $300. These items should not add appreciably to the cost of a renovation.

RESPONSE TO RECOMMENDATION - IMPLEMENTATION PLAN

3f. In 1996, the School Construction Authority contracted with a design consultant to develop new Room Planning Standards for Science Laboratories and Demonstration Rooms. These new standards incorporate emergency gas shut-off valves, ventilation hoods, eye wash stations and power packs. They will be finalized for publication and distribution by July, 1998. They are being used in developing the scope and designs for new or rehabilitated science laboratories. Each scope of work is reviewed by School Facilities as well as by the Division of High Schools for approval. Meetings are held at critical points during the science laboratory construction phases with the SCA, as necessary. See the attached sample of a BOE Room Planning Standard for a science laboratory.

IMPLEMENTATION DATE

Current Procedure

RESPONSIBILITY CENTER

Signature: Rose Diamond

Print Name: Rose Diamond

6/29/98
Date

Print Title: Sr. Director For Capital Planning & Development

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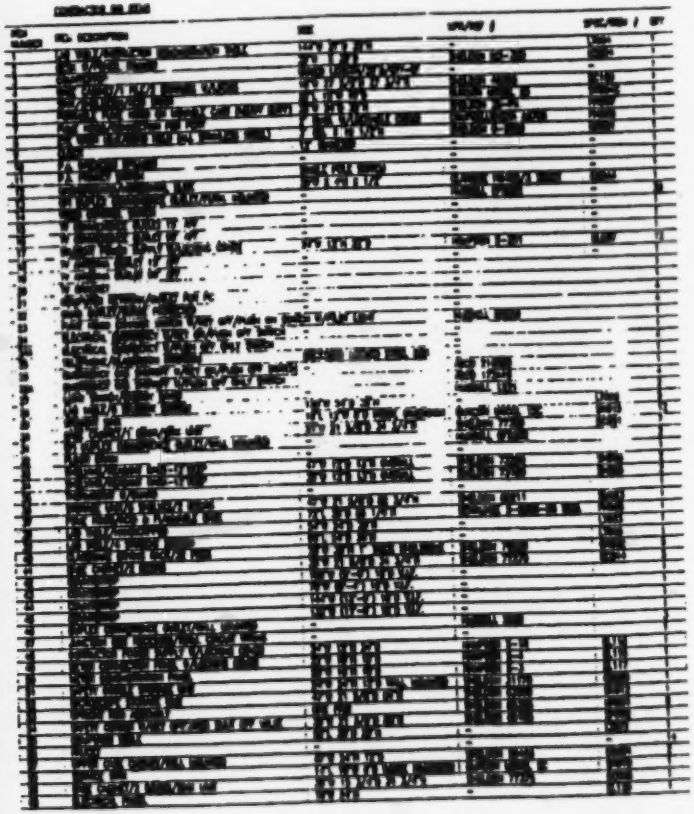

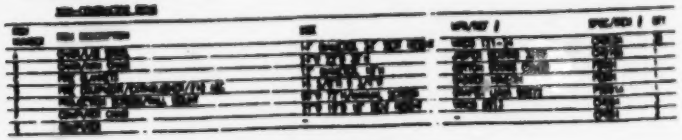

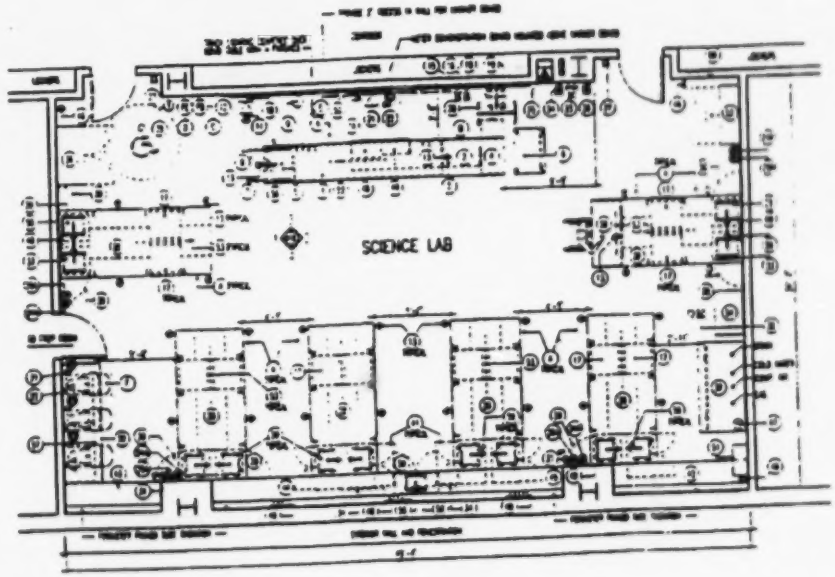

Science Laboratories

ROOM PLANNING STANDARDS

Standard Perimeter Laboratory

PROGRESS ISSUE
NOT FOR CONSTRUCTION

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END

U.S. Dept. of Education

Office of Educational
Research and Improvement (OERI)

ERIC

Date Filmed
October 05, 2000